a proposal for citizen review

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community safety

THE COMPREHENSIVE PLAN OF SAN FRANCISCO

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DEPARTMENT OF CITY PLANNING 100 LARKIN STREET · SAN FRANCISCO, CALIFORNIA 94102

JULY 1974

TO THE HONORABLE MEMBERS OF THE CITY PLANNING COMMISSION:

I am pleased to submit to you the accompanying report, COMMUNITY SAFETY PLAN, A Proposal for Citizen Review, which proposes the seventh element to the Comprehensive Plan. This report is the culmination of a year-long study by the staff of the Department of City Planning to identify and evaluate geologic and fire hazards within San Francisco. The objectives and policies section of this report outlines a course of action by which these hazards can be effectively addressed. Adoption of this section as the COMMUNITY SAFETY PLAN for The Comprehensive Plan of San Francisco can provide the means for increasing safety from seismic hazards in San Francisco.

The COMMUNITY SAFETY PLAN proposed in this report is intended to meet State requirements that general plans of local government contain a seismic safety element and a safety element. This requirement was to a large extent an outgrowth of concerns by a public made dramatically aware of possible seismic dangers by the 1971 San Fernando earthquake, and the need to make our communities safer from seismic hazards. The intent of the required elements is to address geologic and fire hazards; the COMMUNITY SAFETY PLAN incorporates the requirements of the two elements.

The plan is presented for citizen review to encourage discussion of proposed objectives and policies and of implementation programs for the safety of the community. The plan will be revised in accordance with ideas and criticisms received from citizens and public agencies during the review process.

The revised objectives and policies section will be presented to you for adoption as part of the Comprehensive Plan; the revised implementation programs will be presented to you for your endorsement.

Sincerely,

Allan B. Jacobs

Allan B. Jacobs
Director of Planning

A PROPOSAL FOR CITIZEN REVIEW

COMMUNITY SAFETY PLAN

for THE COMPREHENSIVE PLAN OF SAN FRANCISCO

SAN FRANCISCO DEPARTMENT OF CITY PLANNING JULY 1974

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Community safety plan
for the Comprehensive
1974.

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CONTENTS

PAGE 1 PREFACE
RELATION TO COMPREHENSIVE PLANNING

4 BACKGROUND
8 SEISMIC INVESTIGATIONS
    Geologic Investigation
    Structural Investigation
        Pre-Code, Type C Buildings
        Lifelines
22 Impact/Implications of Geologic and Structural Investigations
24 EMERGENCY OPERATIONS
        Administration and Plans
        Physical Sites and Facilities
        Fire-fighting Capability
33 LIFE SAFETY/LEVEL OF RISK
35 HAZARD ABATEMENT

36 SUMMARY OF OBJECTIVES AND POLICIES

39 OBJECTIVES AND POLICIES
    LIFE SAFETY
    PRESERVATION
    EMERGENCY OPERATIONS
    RECONSTRUCTION

52 PROGRAMS
    LIFE SAFETY
    PRESERVATION
    EMERGENCY OPERATIONS
    RECONSTRUCTION

MAPS/DIAGRAMS

PAGE
4 THE CIRCUM-PACIFIC SEISMIC BELT
5 PLATE MOVEMENT ALONG SAN ANDREAS FAULT
5a ACTIVE FAULTS IN SAN FRANCISCO BAY AREA
8a FAULT LOCATION IDENTIFIED
ESTIMATED INTENSITY OF FUTURE GROUND SHAKING
10a POTENTIAL LANDSLIDE AREAS
POTENTIAL LIQUEFACTION HAZARD AREAS
12a POTENTIAL SUBSIDENCE HAZARD AREAS
POTENTIAL TSUNAMI INUNDATION AREAS:
Due to 20 Foot Tsunami at the Golden Gate
12b POTENTIAL INUNDATION AREAS DUE TO RESERVOIR FAILURE
14a STRONG-MOTION INSTRUMENTS IN SAN FRANCISCO
18a ESTIMATED BUILDING DAMAGE LEVELS
FOR A "1906 TYPE" EARTHQUAKE
20a DENSITY OF LIVING UNITS IN PRE-CODE TYPE C BUILDINGS
20b DENSITY OF PRE-CODE TYPE C NON-RESIDENTIAL BUILDINGS
27a PRELIMINARY PROPOSED EMERGENCY OPERATIONS DISTRICTS
AND FACILITIES, ZONE 4
30a AUXILIARY WATER SUPPLY SYSTEM
44a SPECIAL GEOLOGIC STUDY AREAS
53a DENSITY OF PRE-CODE (1948) TYPE C RESIDENTIAL UNITS
(by 1970 Census Tracts
53a DENSITY OF PRE-CODE (1948) TYPE C
NON-RESIDENTIAL BUILDINGS (by 1970 Census Tracts)

PHOTOGRAPHS

7 DAMAGE TO CITY HALL LOOKING NORTH ON LARKIN STREET
APRIL 23, 1906
10 LANDSLIDE ON SAN JOSE AVENUE AT HIGHLAND AVENUE
MARCH 21, 1966
11 LIQUEFACTION GROUND FAILURE AT LAKE MERCED
1957 DALY CITY EARTHQUAKE
11 GROUND FAILURE ON CAPP STREET BETWEEN 18TH & 19TH
STREETS - 1906 SAN FRANCISCO EARTHQUAKE
19 DAMAGE TO TYPE C MASONRY STRUCTURES IN SEATTLE
1965 PUGET SOUND, WASHINGTON EARTHQUAKE
21 FREEWAY INTERCHANGE
POWER STATION
VAN NORMAN DAM
DAMAGE CAUSED BY 1971 SAN FERNANDO EARTHQUAKE

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PREFACE

Comprehensive considerations of seismic hazards have long been neglected in California. The San Fernando earthquake of February 9, 1971 provided the impetus to spur public action to remedy this situation. Legislation was adopted at the State level requiring city and county general plans to include a seismic safety element and a safety element. The legislation called for "an identification and appraisal of seismic hazards" by a seismic safety element and "the protection of the community from fires and geologic hazards" by a safety element.

The requirements for the two closely related general plan elements have been addressed in the preparation of the COMMUNITY SAFETY ELEMENT of the Comprehensive Plan of San Francisco. The purpose of this element is to provide the basis for inclusion of geologic and fire hazard concerns in the planning-development process. The fundamental goal of the element is to establish ways to reduce the risk to San Franciscans from geologic and fire hazards.

This proposal for citizen review is organized into three major sections -- Background; Objectives and Policies; and Programs. The Background section presents, in general terms, the subject of seismicity at both the global and more local levels. The major investigations conducted in preparing this proposal -- geology, structures, emergency operations, reconstruction -- are documented and the findings and implications for planning presented. The conclusion of this section discusses life safety concerns and the kinds of risks the community faces from seismic hazards as well as needs for abatement of identified hazards.

The second section, Objectives and Policies, is organized into four major areas of concern: (1) Life Safety, proposing a scale for acceptable levels of risk from structures , and guidelines for existing and new development; (2) Preservation, addressing the needs for preserving the architectural character of buildings while abating hazards; (3) Emergency Operations, stressing the important needs for emergency services and facilities; and (4) Reconstruction, proposing ways to approach rebuilding following a major disanter. It is this second section that will, after public review, be revised and proposed to the City Planning Commission for adoption as part of the Comprehensive Plan of San Francisco.

The third and final section is Programs. This section outlines short- and long-range actions that can be taken to implement the objectives and policies of the preceding section. Due to the varying time span encompassed by the programs, and needs for frequent modifications, they are not proposed for adoption as part of the Comprehensive Plan but only for endorsement by the City Planning Commission.

Considerable research and several specific investigations were required to provide an understanding of the nature and scope of seismic problems, and to enable development of meaningful planning policies for reduction of risks from seismic hazards. As part of these efforts five background papers were prepared -- #1 STRONG-MOTION INSTRUMENTATION, #2 SAN FRANCISCO PARAPET ORDINANCE, #3 POST-DISASTER FINANCIAL ASSISTANCE, #4 EMERGENCY OPERATIONS CENTER, #5 EMERGENCY OPERATIONS PLAN. These papers, and the comments received on them from numerous interested citizens, professionals and organizations, were important to the development of the policies contained in the proposed element.

Special expertise was required to undertake the investigations needed to evaluate geologic and structural hazards in the city. The firm of John A. Blume & Associates, Engineers, was engaged to conduct these important investigations, and to advise the Department of City Planning regarding planning policies and programs that would evolve from their work.

Especially important to the preparation of this report was the interest, assistance and advice of many individuals and public agencies at the Federal, State, Regional and local levels. Of particular value to the development of policies and program strategies for the Element was the continuing assistance of the San Francisco Department of Public Works, the Mayor's Office of Emergency Services, and the Board of Supervisors' Seismic Investigation Survey and Hazard Advisory Committee (SISHAC). The participation of all these individuals and agencies was essential as a means for comprehensive examination of seismic hazards, and to focus the proposed COMMUNITY SAFETY PLAN on the most relevant issues.

RELATION TO COMPREHENSIVE PLANNING

The City charter assigns to the Planning Commission the responsibility to "adopt and maintain, including necessary changes therein, a comprehensive, long term, general plan for the improvement and future development of the city and county". In meeting this responsibility, the Department of City Planning has organized its work program around a planning-development process involving five functional components: (1) objectives and policies, (2) improvement plans, (3) development strategy, (4) neighborhood planning, and (5) development programming.

The first component, policy development, establishes long-range objectives and policies to guide the City in terms of ten planning

elements: residence, urban design, transportation, recreation and open space, conservation, community facilities, community safety, commerce and industry, noise control, and education. Improvement plans translate these longer-run objectives and policies into shorter-term programs and measurable targets to the extent possible. Development strategy assigns priorities to citywide actions and allocates public resources as necessary to carry out program recommendations. Neighborhood planning enables the interests and needs of community groups to be incorporated into public programs for their neighborhoods. Development programming is the scheduling and guiding of specific, detailed projects, both public and private.

The COMMUNITY SAFETY ELEMENT is the seventh major project of San Francisco's planning and development process to be completed. It represents the first two components of the process: long-range objectives and policies and short-term programs based upon them; and the two general plan elements required by State law: seismic safety and safety. Parts of this Element relate very closely to other elements of the Comprehensive Plan, especially residence, urban design, recreation and open space, and community facilities. It is important that implementation strategies for this Element be integrated with those of other elements of the Comprehensive Plan.

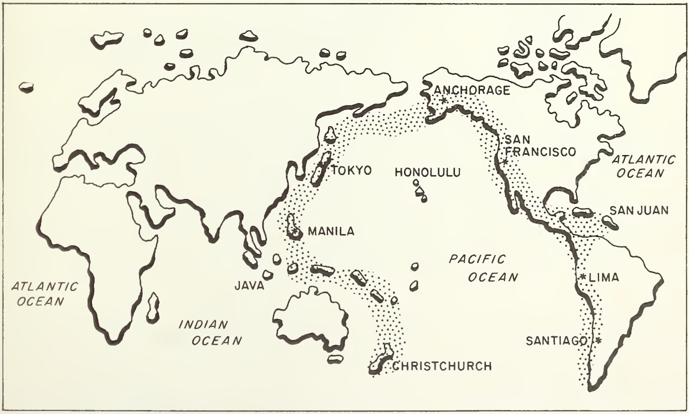
The Element is preliminary. It is hoped that in the process of reviewing and revising the Element, a concensus can be reached on objectives to reduce seismic hazards in San Francisco, and the means for achieving them. As in all parts of California, seismic hazards exist in San Francisco, but much can be done to reduce these hazards. Participation by citizens and public officials in the review process will assure a final plan that can serve as a basis for private and public decisions, and initiation of appropriate seismic hazard reduction actions for San Francisco.

THE COMPREHENSIVE PLAN OF SAN FRANCISCO

ADOPTED	IN PREPARATION	TO BE DONE
• Residence	• Community Facilities	• Education
• Urban Design	• Community Safety	
• Transportation	• Noise Control	
• Recreation & Open Space	• Commerce & Industry	
• Conservation		

BACKGROUND

Most of the State of California lies within a band which covers only a small portion of the earth's surface but has within it 80 per cent of world seismic, or earthquake activity. This band is the Circum-Pacific Seismic Belt, or the "Ring of Fire", so-called because the majority of the earth's volcanoes occur within this belt (as do virtually all psychedelic mushrooms in the world).



THE CIRCUM-PACIFIC SEISMIC BELT
Source: November 1971 California Geology

An understanding of why this seismic activity is on one relatively narrow strip has emerged only in the last decade. It appears that the earth's surface is a mosaic of perhaps twenty huge blocks or segments. Pushed or pulled by titanic forces, these segments -- geologists call them "plates" -- slowly drift. The place of contact, or movement, between two plates is called a fault or fault zone. The well-known San Andreas Fault is where the Pacific Plate and the North American plate make contact.

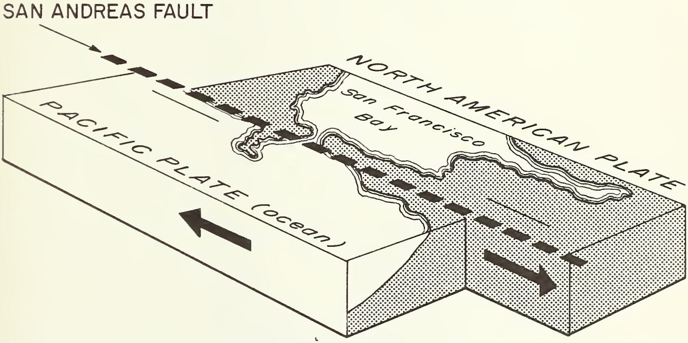
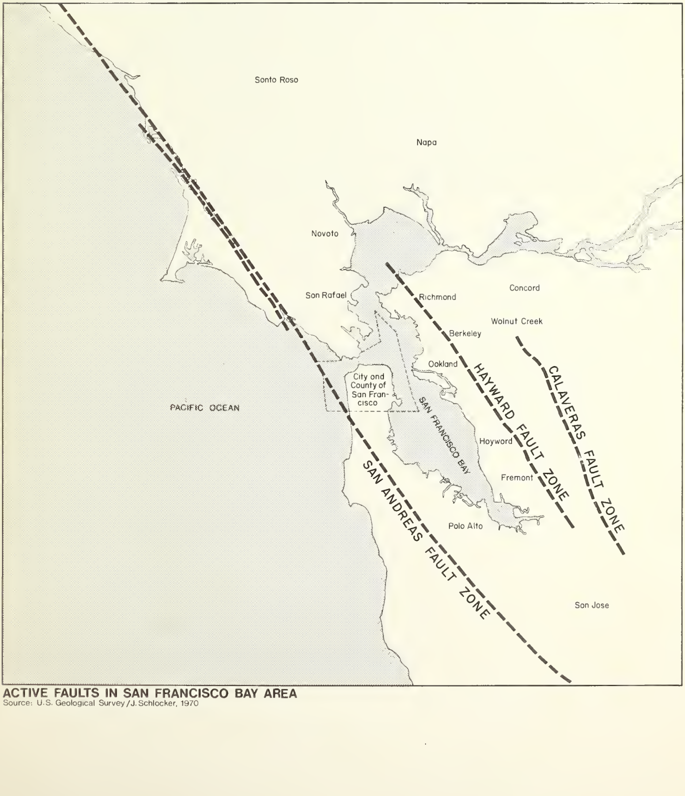


PLATE MOVEMENT ALONG SAN ANDREAS FAULT
Source: IEEE Spectrum, September 1973

In some cases plates slide smoothly past each other, causing what earth scientists call fault "creep": that is, the slow, steady movement of one plate in relation to another. In other cases, tremendous pressure along the plate borders creates a friction which does not allow movement; the plate edges lock. However, the plates themselves continue to advance, bending the rock at the boundary until the strain is too great. Then the rock snaps along the fault and shifts violently back toward equilibrium, like a bent stick breaking. This shifting rock causes the devastating shock waves we know as an earthquake.

Even though the shock waves generated by earthquakes may travel for great distances, they originate within or directly on active faults. Such a shock wave originating on an active fault can have a widespread effect upon the earth as it spreads from its point of origin. If the shock were centered under the ocean -- for instance along a fault somewhere in the Pacific Ocean between Hawaii and the Mainland -- it might create a seismic sea wave or tsunami. These are also commonly known as tidal waves; however,



ACTIVE FAULTS IN SAN FRANCISCO BAY AREA

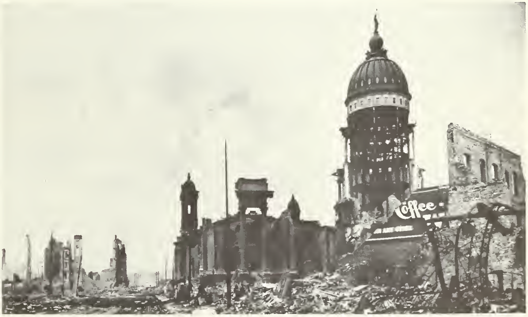
Source: U.S. Geological Survey/J. Schlocker, 1970

this is incorrect as a tsunami is generated by seismic activity, not tidal action. Tsunamis gain in velocity as they travel, potentially moving at more than 400 miles per hour and reaching a maximum vertical run-up, or height, of more than 35 feet. There is also an inland cousin of the tsunami called a seiche; a seiche could occur in enclosed bodies of water such as bays, lakes, reservoirs and large water tanks.

The most common expression of earthquakes is ground shaking, The shaking occurs as shock waves generated by the snapping of two rock "plates", move through the materials of the earth's crust. The strength and duration of a shock wave will vary according to the types of earth materials the wave is passing through. For example, the wave will pass rapidly through solid rock but will pass more slowly and increase in intensity through bay mud. Therefore, the degree of ground shaking is dependent upon both the proximity to the fault and the composition of the underlying geologic formations. If an earthquake were to have a major effect in the San Francisco Bay Area, it would probably originate on or near either the San Andreas Fault along the Pacific Coast or the Hayward or Calaveras Faults in the East Bay.

In the broadest sense, the structures of man are the key factor in an analysis of earthquake hazards. In an open meadow, it would usually be possible to ride out the most massive earthquake in relative safety. It is the structures built by man in seismic areas which create hazardous situations.

In these areas all structures are affected by geologic hazards of some kind. Ground shaking, and the transmission of earthquake vibrations from the ground into structures, is the most universal hazard, and such shaking may cause structural collapse. All areas of San Francisco will be subject to some degree of ground shaking in a large earthquake. Because buildings respond in different ways, depending upon the type of construction and foundations, and the type of soil the building is resting on, proximity to a fault may not be the key indicator of damage potential. The 1906 earthquake caused the most severe damage from ground shaking in the northeast corner of San Francisco, the area farthest from the San Andreas Fault.



Source: BANCROFT LIBRARY

DAMAGE TO CITY HALL LOOKING NORTH ON LARKIN STREET
APRIL 23, 1906

Unlike most areas of California, San Francisco is an almost totally constructed city; its borders have been defined for more than 100 years and very little land is left undeveloped. Many other cities still have the opportunity to limit or modify construction on sites of potential geologic risk. San Francisco must begin to approach the problem of seismic hazards by considering the interaction between already existing structures and their underlying geology. This is the most important factor in the determination of the direction for seismic hazard considerations in San Francisco. These considerations must include: (1) an identification and resolution of possible hazards in existing urban development, and (2) a determination of guidelines for future development.

SEISMIC INVESTIGATIONS

Investigations were undertaken to determine the nature, scope and effects of seismic hazards in San Francisco. Fundamental to the consideration of seismic hazards was an evaluation of the geologic environment' of the city; closely related was an evaluation of structures, both buildings and other structures, including "lifelines" -- the essential public systems, facilities and utilities such as bridges and roadways, hospitals, and water supply. The engineering consultant was engaged by the City Planning Commission to conduct these two investigations.

Investigation of emergency operations was another important factor in the program. This explored the state of preparedness, in San Francisco, to respond to community needs in the event of a disaster.

The fourth major area of investigation was directed towards the evaluation of planning needs for post-disaster reconstruction. Problems faced by other cites following a major earthquake, and other factors, were studied to determine what should be anticipated in San Francisco and appropriate actions that could be taken.

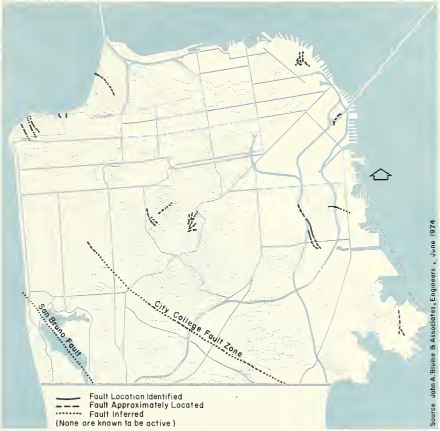
Geologic Investigation

In an active earthquake area such as San Francisco, the underlying geology poses a potential hazard to structures and property. The objective of the geologic study was to identify, describe, and analyze geologic and seismological factors of earthquake hazards within San Francisco. The study relied mainly on the extensive material previously published by government agencies, private firms and individuals; no new field investigations were conducted for the study.

A generalized geologic map was compiled, which combined multiple factors, such as the location and extent of major geologic formations, in San Francisco that have distinctive engineering characteristics and fault locations; this map served as a basis for the identification and evaluation of individual geologic factors.

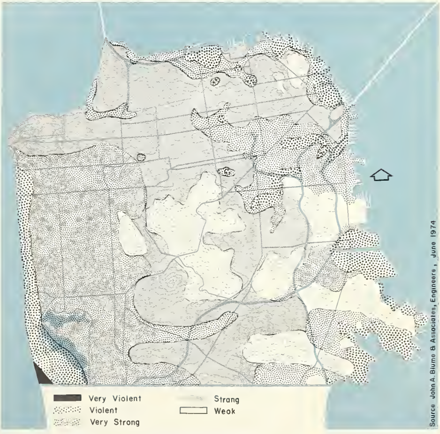
These factors were mapped to define areas of specific hazards or potential hazards, with accompanying descriptions. Each map presents a separate geologic factor to reduce possible misinterpretation of the information.

Faults: No active faults are known to exist within San Francisco. Ancient, inactive faults (that is, those faults which have had no movement in the last 10,000 years) are identified; none is


San Bruno Fault
City College Fault Zone
Fault Location Identified
Fault Approximately Located
Fault Inferred
(None are known to be active)

Source John A. Blume & Associates, Engineers, June 1974

FAULT LOCATION IDENTIFIED



Source John A. Blume & Associates, Engineers, June 1974

ESTIMATED INTENSITY OF FUTURE GROUND SHAKING

considered capable of producing as large an earthquake as has occurred on the San Andreas fault, and none is expected to move in any foreseeable future earthquake.

There are, however, major faults in the vicinity of San Francisco that are known to be active and will be the source of future large earthquakes. The largest fault near San Francisco is the San Andreas fault which ruptured during the 1906 earthquake. The San Andreas fault passes along the Pacific Coast within about one mile of the southwest corner of the city and about nine miles from the commercial center of the city.

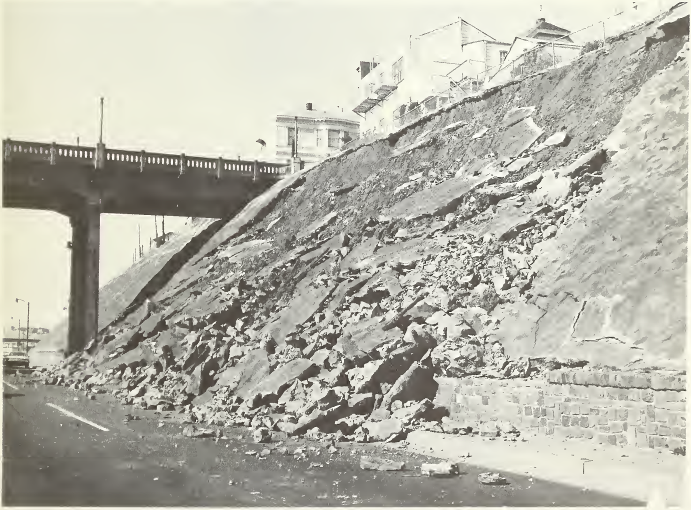
Two other major active faults in the Bay Area are the Calaveras fault, which passes east of San Jose near Pleasanton, and the Hayward fault, trending in a northwesterly direction along the base of the hills in Berkeley, Oakland and San Leandro. Both of these faults may be expected to move in future earthquakes, although neither is believed capable of producing earthquakes as damaging as those originating on the San Andreas fault.

Ground shaking: Predictions of future ground shaking were based largely on analyses of the 1906 earthquake. Even though the next large earthquake may originate at a different point along the San Andreas fault, site characteristics change little or not at all; and the distribution of ground-shaking intensity due to future earthquake will be approximately the same as in the 1906 earthquake.

In general, the upper portions of the hills, that consist of bedrock with little or no soil cover, will undergo lesser degrees of ground shaking. The lower portions of the city, built on man-made fill placed over soft bay muds, will have the highest degrees of shaking. The zones lying between the outcropping portions of the hills and the man-made fill or deep-soil areas will generally undergo intermediate levels of shaking with some localized anomalies.

Landslide areas: In comparison with other parts of the Bay Area,San Francisco has had relatively few landslides. There are, however, some landslide-prone areas; the hills underlain by Franciscan-type rock are the most susceptible. Historic examples are the eastern and northeastern margins of Telegraph Hill, the southern part of the San Miguel hills near Mr. Davidson, and the edges of Bayview Hill. Landslides are also abundant along the high sea cliffs between Fort Point and Seal Rocks.

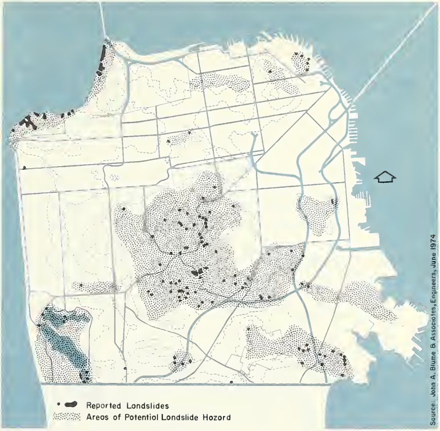
A large part of the city is blanketed by dune sand, particularly on the western slopes. This type of sand, in low-lying areas where the water table is near the ground surface, may be subject to sliding during earthquakes. During the San Francisco earthquake of 1957 there were several instances of landsliding around the margin of Lake Merced. However, most of the dune sands in San Francisco are not situated at a low level near the water table.



Source: SAN FRANCISCO DEPARTMENT OF PUBLIC WORKS

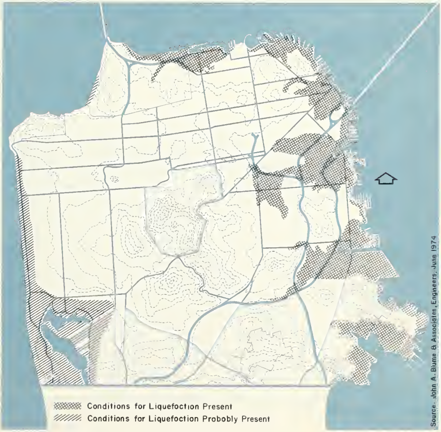
LANDSLIDE ON SAN JOSE AVENUE AT HIGHLAND AVENUE

MARCH 21, 1966



Source: John A. Blume & Associates, Engineers, June 1974

POTENTIAL LANDSLIDE AREAS


Conditions for Liquefaction Present
Conditions for Liquefaction Probably Present

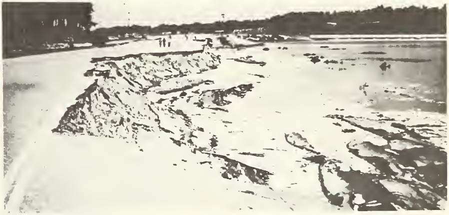
Source: John A. Blume & Associates, Engineers, June 1974

POTENTIAL LIQUEFACTION HAZARD AREAS

Liquefaction: This ground failure phenomenon is usually associated with earthquakes of intense and prolonged ground movement. The process occurs when the ground shaking forces water between particles of loose or medium-dense materials (sands, silts), causing them to lose stability and liquefy much like quicksand. Liquefaction often causes landslides (such as those previously mentioned around Lake Merced) and building settlement, but only during the actual shaking. When the ground shaking stops, the soil usually returns quickly to its pre-shaking state.

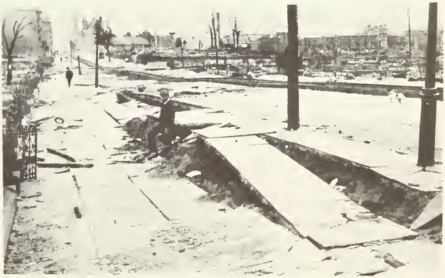
Liquefiable soils pose a substantial hazard to San Francisco. Earthquake engineering experts generally agree that a great percentage of the damage caused by the 1906 earthquake was due to the liquefaction and subsequent subsidence of man-made land.

All areas where man-made fill rests upon soft bay mud or unconsolidated sand may be considered to possess a liquefaction potential. Areas underlain by dune sand where the water table is relatively close to the ground surface also have liquefaction potential.



Source: M. G. BONILLA

LIQUEFACTION GROUND FAILURE AT LAKE MERCED
1957 DALY CITY EARTHQUAKE



Source:
JOHN A. BLUME & ASSOCIATES

GROUND FAILURE ON CAPP STREET BETWEEN 18TH & 19TH STREETS
1906 SAN FRANCISCO EARTHQUAKE

Subsidence: Although it can occur under static (normal) conditions, subsidence -- uneven local settlement of the ground's surface -- is frequently activated by strong ground motion, such as that from a major earthquake. In San Francisco, the subsidence hazard area is predominantly restricted to districts of "made" land, that is, land reclaimed by filling shallow water and marsh areas. In general, this comprises those low-lying filled areas in the eastern portion of the city in which the fill either is known to have subsided in the past or may subside because of underlying compressible bay muds.

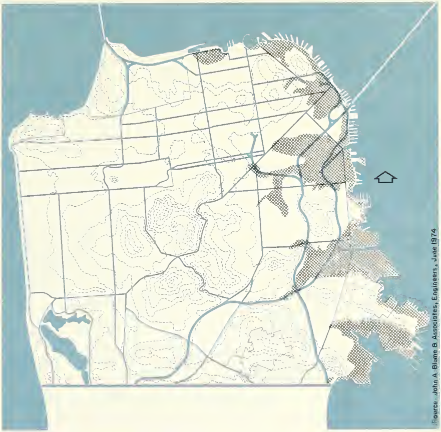
Tsunamis and Seiches: Although tsunamis have been unknown in San Francisco in recent time, an understanding of their general properties should be part of any disaster-preparedness scheme. The frequency of this phenomenon is unpredictable: for example, the Hawaiian Islands had no large tsunamis for almost 70 years, then had four seriously damaging tsunamis over a 15-year span.

The tsunami map indicates inundation areas from a 20-foot run-up, or wave height, the maximum probable tsunami at the Golden Gate. The maximum recorded run-up at the Golden Gate is 7.5 feet, which followed the 1964 Alaskan Earthquake.

As part of a disaster preparedness warning system, the following properties of a tsunami should be explained to the public:

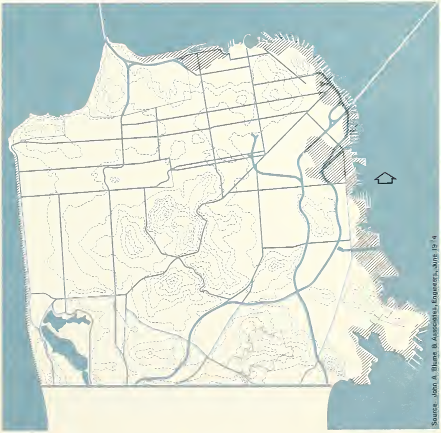
(1) A tsunami is not a single wave but a series of waves, and the first wave is not necessarily the largest;
(2) The swift currents generated by receding or in-coming waves are an additional hazard, and these can damge moored boats and marinas;
(3) Before a tsunami, or after the first wave, water may withdraw from the coast, exposing large areas of the shore. These exposed areas often attract people, who may then be trapped by the next in-coming wave.

The partly enclosed basin of San Francisco Bay is also subjectd to a possible inland wave, or seiche, from movement along the Hayward, San Andreas or Calaveras faults. The maximum probable seiche would cause an estimated 10-foot run-up on either side of the Bay.



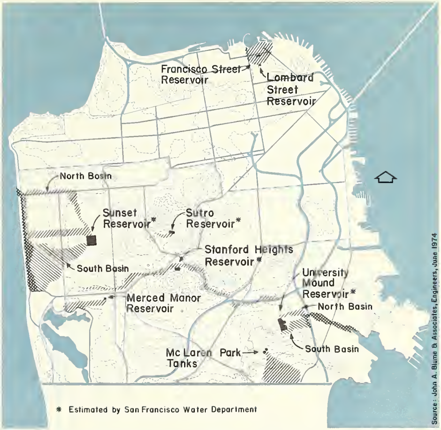
POTENTIAL SUBSIDENCE HAZARD AREAS

Source: John A. Blume & Associates, Engineers, June 1974



POTENTIAL TSUNAMI INUNDATION AREAS: Due to 20 Foot Tsunami at the Golden Gate

Source: John A. Blume & Associates, Engineers, June 1974



* Estimated by San Francisco Water Department

Source: John A. Blume & Associates, Engineers, June 1974

POTENTIAL INUNDATION AREAS DUE TO RESERVOIR FAILURE

Reservoir Failure: Reservoirs, which confine large volumes of water in tanks above ground or behind dams or embankments, represent a potential hazard due to failure caused by ground shaking. In case of failure, the released water would cause property damage and might be a hazard to human life.

Based on certain specific criteria, the following categories were developed to identify reservoirs that might have an earthquake hazard: reservoirs above ground level, elevated water tanks, and reservoirs and water tanks with storage capacity of one million gallons or more.

Reservoirs with a capacity of less than one million gallons were not considered to present a significant hazard; those with below ground surface locations confined by natural ground rather than dams or embankments, were not considered subject to earthquake failure. Inundation, or flooding, areas were calculated and mapped for large reservoirs and tanks identified as subject to possible failure from earth shaking. Evacuation plans and routes are now being developed by the San Francisco Office of Emergency Services for each of these areas.

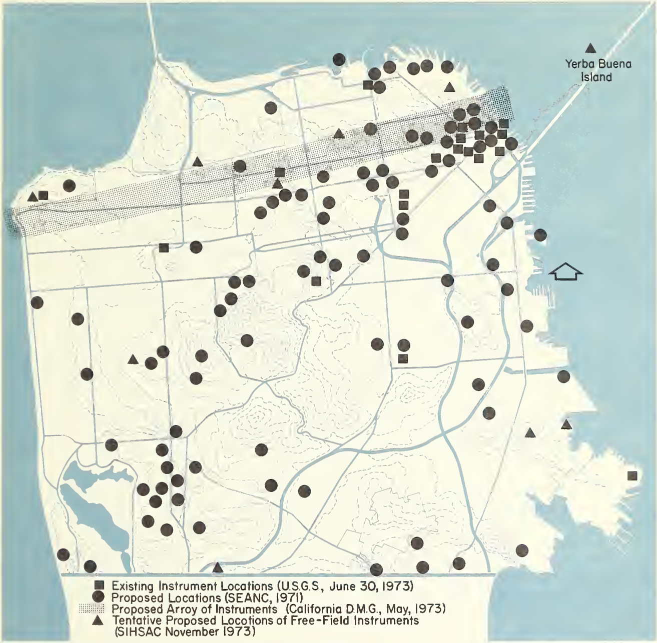
Seismic Research:: Seismic research is necessary to advance an understanding of the complex ways in which the earth moves. It provides purely scientific information as well as the important by-product of additional data, on ground motion and the response of structures to that motion, essential to development of standards for structural design and general land use planning. There are active seismic research projects in the San Francisco Bay Area, but relatively little is being done within San Francisco -- primarily because of the lack of active faults.

There is, however, a program in San Francisco to monitor the intensity of ground movement during strong earthquakes. Background paper #1, STRONG-MOTION INSTRUMENTATION, examined and documented the program as it is conducted in San Francisco. The strong-motion instrumentation program is part of a wider scale program conducted by the United States Geologic Survey and the California Division of Mines and Geology. Strong-motion instruments are seismographs modified to measure only the strong vibrations generated by local earthquakes; they are especially useful in determining how man-made structures respond to earthquakes.

Information gathered from strong-motion instruments after the San Fernando earthquake of 1971 has proven invaluable in estimating the effects of future earthquakes on buildings. While the presence of strong-motion instruments will not alleviate damage from ground shaking, the data they can provide are essential to determine the actual effects of ground motion and soils structure interaction in order to improve design criteria for earthquake-resistive structures.

There are approximately twenty existing strong-motion instrument installations in San Francisco, some in structures, some in the ground -- "free field". To provide important data on ground motion in San Francisco at least ninety more installations are needed according to professionals active in this field of research.

The existing installations were made primarily on an ad hoc basis, as sites became available. The sites proposed by geologists and engineers for additional installations take into account the desirable distribution of instruments according to a variety of geologic environments and structural conditions. Specific formal criteria for new installations are being developed by the Seismic Engineering Branch of the U.S. Geological Survey. They are being assisted in this effort by professional associations of engineers and geologists.


Yerba Buena Island
■ Existing Instrument Locations (U.S.G.S., June 30, 1973)
● Proposed Locations (SEANC, 1971)
▨ Proposed Array of Instruments (California D.M.G., May, 1973)
▲ Tentative Proposed Locations of Free-Field Instruments (SIHSAC November 1973)

STRONG-MOTION INSTRUMENTS IN SAN FRANCISCO

Structural Investigation

The objective of the seismic investigations was to identify, describe and evaluate earthquake hazards. The primary hazard to human safety in an earthquake-prone area is from falling construction materials and the collapse of walls, ceilings or whole buildings. The likely result of interaction between already existing structures and their underlying geology under seismic stresses and the structural condition of the buildings themselves, are principal indicators of the risk to human life.

To determine where hazards from structures might exist, an extensive evaluation of the existing structures in San Francisco was undertaken. The major thrust of the study was an estimate of areas of potential damage in San Francisco that could result from a repetition of the 1906 earthquake, which originated on the San Andreas fault and had a magnitude of 3.3 on the Richter Scale.

This study included these other investigations pertinent to estimation of possible damage: (1) an analysis, with the limited data available, of how buildings performed in the 1906 earthquake; (2) an analysis of the performance of buildings in recent foreign earthquakes, such as those in Caracas, Mexico City, Iran, Morocco, Turkey and Colombia; and (3) a detailed review of past revisions to the San Francisco Building Code.

The Building Code review showed that prior to 1906 there were no specific lateral (horizontal) force design requirements and after 1906 there were certain requirements for wind (horizontal) forces. It was not until 1948 that comprehensive lateral force design criteria, specifically considering seismic forces, were added. Because of this distinct change in Code requirements, 1948 became a very important date relative to the estimated susceptibility of structures to failure.

Subsequent seismic building code changes were made in 1956, and again in 1962, 1965, and 1969. The current code is similar to the Uniform Building Code (UBC), which in turn follows the recommendations of the Structural Engineers Association of California. However, in some respects, the current San Francisco requirements exceed those of the UBC. One important example is the requirement for code compliance in remodeling. The San Francisco Code requires a building to meet current structural provisions when remodeling affects more than 30% of the structure; UBC would not require structural compliance until more than 50% of the structure was being remodeled.

The estimation of damage used building data from the City Assessor's Secured Roll Master File, a computerized file with the most extensive information available for existing structures. The data used included the use category of the structure, the year built, the construction type, the number of stories and the total floor area. Geologic hazards were generally not

included in this part of the study; however, geology and local soil conditions were considered in estimating potential ground motion (peak ground acceleration, spectral response acceleration, and predominant periods of deep or soft soil deposits).

Formulas were developed, based upon these factors and the projected response of structures to seismic stresses from a 1906-type earthquake of 8.3 magnitude, to determine estimated levels of damage throughout the city. Potential damage estimates were aggregated on a whole block basis; no specific analysis of any building was conducted for this investigation. The results of the study were, in turn, aggregated by four basic levels of damage and a map prepared to show where the various levels of potential damage might occur. The estimated potential damage levels are described as follows:

Damage Level	Damage Description
Severe:	There would be extensive to complete damage of non-structural elements such as suspended ceilings, pipes and ducts, and glass; and structural damage ranging from heavy to essentially total in some cases. Some collapses would occur and damage to many buildings would make replacement more economical or desirable than repair. There would also be damage as described for the lesser categories.
Heavy:	There would be heavy damage to architectural and other nonstructural elements and materials such as cornices, curtain walls, and tile or masonry veneers. Structural damage would be extensive. Some structures would be out of plumb. There would also be damage as described for the lesser categories.
Moderate:	There would be damage to many nonstructural elements and materials: partitions, walls, stairways, and chimneys. There would be some structural damage but not in all cases. There would also be damage as described for slight category.
Slight:	There would be some cracked and damaged walls, partitions and stairways, broken chimneys, and parapets and ornamentations dislodged. Structural damage would generally be minor, if any.

Based on engineering data and other limited data, it is estimated that loss of life in the severe damage level areas could average one percent or more of the population of the area. Injuries requiring hospitalization would be many times the number of fatalities. A figure of 10 to 15 times more injuries than fatalities would be a reasonable estimate.

This basis of estimation of potential deaths and injuries would indicate the possibility of 350 fatalities and 3500 to 5200 injuries in the nearly two-hundred blocks where severe damage may occur during a 1906-type earthquake. It should be noted that these figures are derived from resident population figures and there may be a higher daytime population in many of the blocks.

Property loss would also vary with the ratings in the map. These average losses would essentially follow the damage level ratings based, as before, on a 1906-type earthquake affecting buildings existing in 1973.

Estimated Average Percentage of Those in Area at the Time

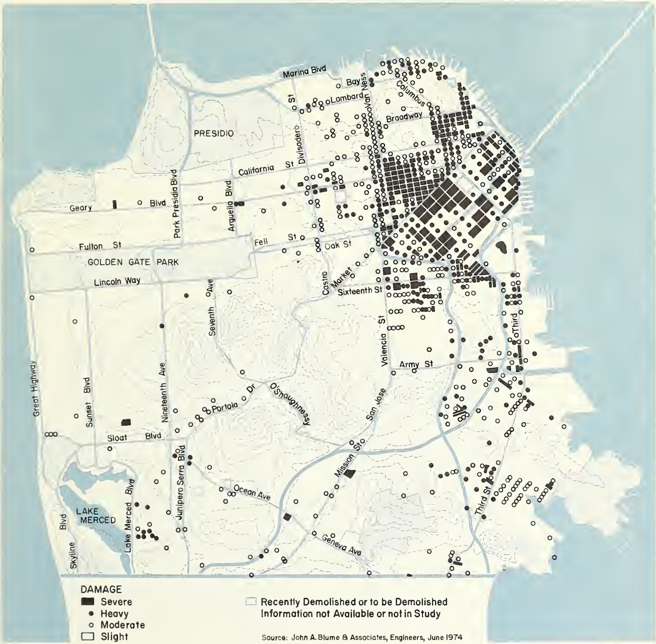
Damage Level	Deaths	Injuries Requiring Hospitalization	Estimated Average Property Loss as Percentage of Replacement Cost
Severe	1.0%	15%	75%
Heavy	0.3%	4%	50%
Moderate	0.1%	1%	25%
Slight	0.02%	0.2%	5%

Certain blocks and areas, as indicated on the map, were not covered in the investigation because there was insufficient information to estimate building damage; some structures other than a building occupied the area; the area was not within the scope of the study such as State or Federal lands; or buildings have recently been, or are soon to be, demolished.

In no case should damage intensity levels indicated on the map be applied to individual buildings; no specific analysis of any building was conducted for this evaluation. The building data used are those obtained from the Assessor's records and the damage is estimated by approximate, statistically based methods. For these reasons, damage estimated for individual buildings could vary greatly from that shown for a whole block and such estimates cannot be made from this map. The data, however, for larger areas, and for average statistical purposes, are meaningful for overall planning.

In consideration of the building damage estimate map, it is important to note that ground motion, and building resistance to ground motion, are highly random variables, often with extensive variations from average or mean conditions. The data used for derivation of the map are for mean conditions, and variation or exceptions in either direction can be expected in any local area.

The map generally indicates the potential for the most severe damage in the Market-Van Ness-Bay triangle, South of Market Street, and in scattered pockets in the Western Addition and west of Islais Creek. However, many downtown buildings, built in recent years and usually of steel frame construction, might well have lesser levels of damage than older, often smaller structures. For the vast majority of the city, slight or no damage is indicated; this is principally because much of the city is developed with wood-frame residential structures which are generally resilient and relatively safe.



Source: John A. Blume & Associates, Engineers, June 1974

ESTIMATED BUILDING DAMAGE LEVELS FOR A "1906 TYPE" EARTHQUAKE

Pre-Code, Type C Buildings

In addition to the general investigation of structures, an investigation was made of the pre-Code, Type C buildings to determine their distribution throughout the city. Mapping of these structures was considered to be critical to the development of hazard abatement policies and programs. Pre-Code, Type C buildings can be generally defined as those buildings constructed before 1948 that have masonry or concrete exterior bearing walls with wood floor and wood roof construction. Such buildings are of particular interest because they have had a poor record of performance in past earthquakes.

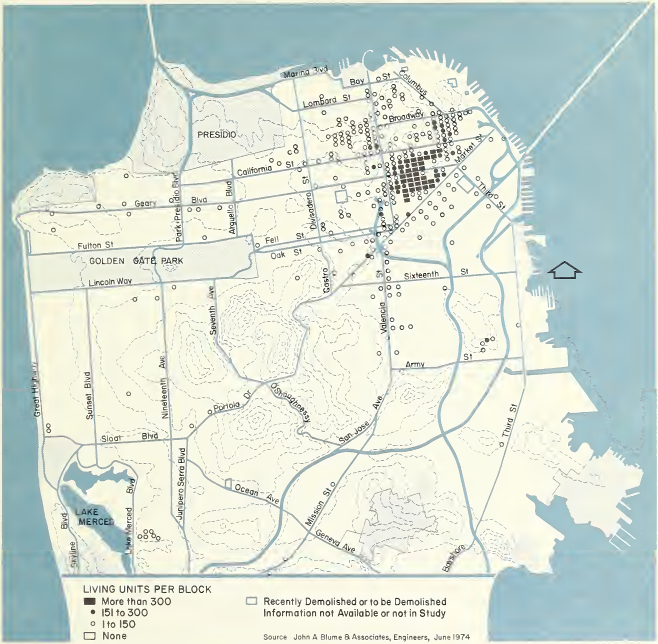
Source: JOHN A. BLUME & ASSOCIATES

DAMAGE TO TYPE C MASONRY STRUCTURES IN SEATTLE
1965 PUGET SOUND, WASHINGTON EARTHQUAKE

To assist in the establishment of priorities for hazard abatement programs, and in the determination of certain emergency operations needs, the locations and densities of pre-Code, Type C buildings were mapped for residential and non-residential uses: residential uses are shown in numbers of living units per block; the non-residential uses in numbers of buildings per block. Many of the blocks in the highest numerical category on both maps are coincident with areas of potential severe damage indicated by the general evaluation of potential building damage.

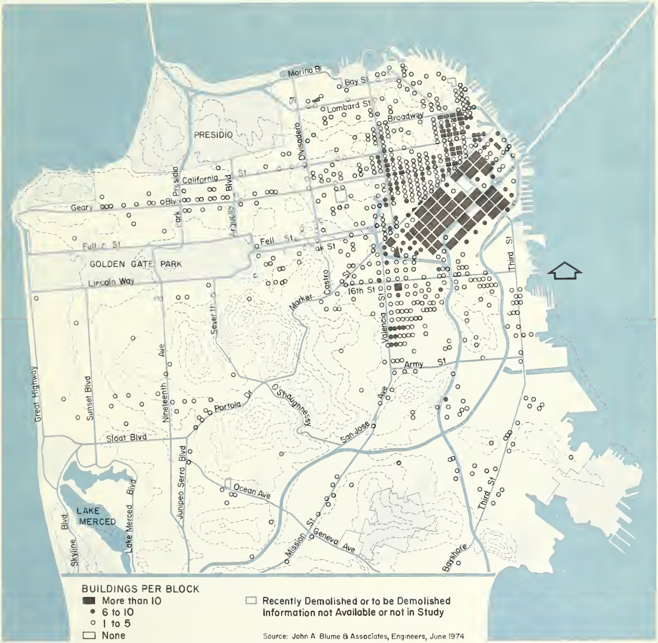
Over 1400 residential buildings were identified as being pre-Code, Type C construction. These buildings contained nearly 35,000 living units and at present construction costs it would take over one-half billion dollars to replace them.

Nearly 2300 non-residential (commercial, industrial, institutional) buildings of pre-Code, Type C construction were identified and the replacement of these, in addition to the residential buildings, could easily total over a billion dollars. That would be only the direct construction costs; other undetermined costs would accrue from relocation needs. It should be emphasized that not all of the pre-Code, Type C residential and non-residential buildings are unsafe, but the probability of building collapse in a major earthquake is high. However, in many cases structural renovation may be possible at less cost than complete replacement.



Source John A Blume & Associates, Engineers, June 1974

DENSITY OF LIVING UNITS IN PRE-CODE TYPE C BUILDINGS

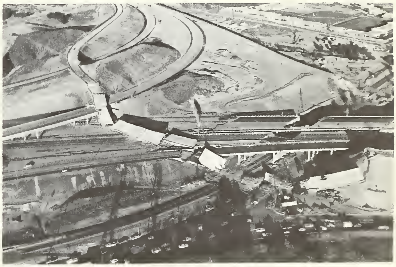


Source: John A Blume & Associates, Engineers, June 1974

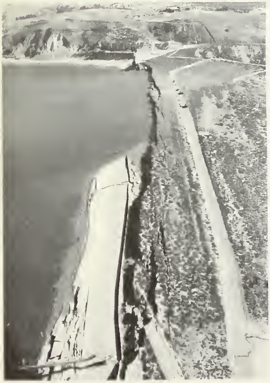
DENSITY OF PRE-CODE TYPE C NON-RESIDENTIAL BUILDINGS

Lifelines

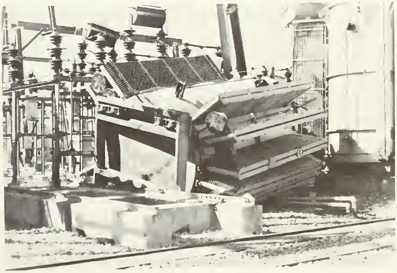
The disastrous effects of an earthquake upon buildings are usually compounded by the failure of "lifelines" -- those utilities, transportation and communications systems essential to public safety and welfare. In both the social and economic sense their failure cannot be tolerated. Yet, as emphasized in recent experiences, especially the San Fernando earthquake of 1971, they do fail with dire consequences to public health and welfare. Well documented examples include failures of dams, freeway bridges, harbor quay walls, gas transmission lines, power distribution systems and communications facilities.



FREEWAY INTERCHANGE



VAN NORMAN DAM



POWER STATION

DAMAGE CAUSED BY 1971 SAN FERNANDO EARTHQUAKE
Source: JOHN A. BLUME & ASSOCIATES

As part of the structural investigation, a survey -- through a questionnaire and follow-up interviews -- was made of critical lifeline services in San Francisco. The principal thrust of the investigation was to determine the degree to which the various departments and agencies considered seismic hazards in the construction and maintenance of both existing and new facilities.

The survey showed that although the agencies responsible for critical lifeline functions in San Francisco are aware of their roles in providing vital services following an earthquake, only half have studied the impact of a major earthquake upon their facilities; fewer than half have developed predictions of probable earthquake damage to their facilities; and still fewer have written and practiced emergency plans for post-earthquake operations.

More importantly, only half or fewer than half of the vital lifeline agencies have conducted specific investigations of their existing facilities for susceptability to ground shaking, motion-induced ground settlement, liquefaction, or deterioration of buildings due to age or settlement. Many agencies, but not all, however, are now requiring pre-construction site-specific geologic and soils analyses in order to ensure that all geologic hazards which might be present are properly considered in the design process.

Considerable further research in the field of lifeline earthquake engineering is needed. "Lifeline earthquake engineering" is a relatively immature professional field. "Building earthquake engineering," in contrast, has developed tremendously since the Long Beach earthquake of 1933 and is a maturing professional field. As advances are made, amendments to the Public Works Code, the Building Code and the City Planning Code, where applicable, will be needed to assure the highest practical level of safety.

Impact/Implications of Geologic and Structural Evaluations

Comprehensive evaluation of geologic and structural hazards provide a basis for detailed land-use planning and hazard abatement programs that will help minimize loss of life, injury, and economic harm in future earthquakes.

The effect of most geologic hazards on buildings can be compensated for by engineering; regardless of their height most structures can be appropriately designed for almost any site. However, the hazards of surface fault rupture and active landslides are extremely difficult and usually costly to compensate for through structural design; land uses for human habitation in areas subject to such hazards must be very carefully considered, and in some cases unequivocally restricted.

Ground shaking in a major earthquake is the most serious seismic hazard in the city of San Francisco. Ground shaking will affect all parts of the city, although damage caused by shaking will be greatest in areas with poor soil stability and among weak, poorly constructed, and poorly designed buildings.

The estimated building damage map is based on the assumption that all buildings are on stable soil and foundations. The geologic hazards should be considered as additional factors. Thus, blocks with a "slight" damage rating that are subject to potential landslide activity should be considered liable to a higher level of possible damage. Liquefaction, subsidence, or inundation from tsunami or reservoir failure could also contribute to damage.

A principal way to approach these and other enumerated hazards is through the San Francisco Building Code. Preliminary geologic and engineering evaluations could be incorporated into building code requirements in ways that would make them appropriate to types of proposed land uses and to the varying degrees of geologic hazard present in different parts of the city.

Specifically, the Building Code could maintain an adequate safety factor against ground shaking in the design of structures. Among other things, special soils engineering and geologic investigations, including any necessary sub-surface exploration could be required in areas of potentially strong ground shaking. Appraisals by earth science consultants could be required in landslide, liquefaction and subsidence hazard areas.

With the specific exceptions of most active landslides, the hazards found in San Francisco can be compensated for through proper pre-construction site investigations and compensating seismic design criteria.

EMERGENCY OPERATIONS

Emergency operations planning is essential for any community likely to be affected by a disaster, in order to establish what measures can and should be taken before, at the time of, and immediately after a disaster to reduce life loss and injury.

To determine the adequacy of preparedness, an investigation and evaluation of the many facets of emergency operations was undertaken and reported in background paper #5, EMERGENCY OPERATIONS PLAN. The evaluation was broken into three major segments: administration and plans, physical sites and facilities, and fire-fighting capability.

Administration and Plans

Although all three levels of government -- Federal, State and local -- are involved in San Francisco emergency operations, the Federal and State governments do not play an active role in preparing and following through with local emergency operations plans. Rather, the role of Federal and State agencies is to fund emergency operations and to formulate and enforce guidelines which accompany that funding.

The City department responsible for the preparation, coordination and implementation of San Francisco emergency planning and activities is the Mayor's Office of Emergency Services (SF/OES). This Office is assisted by two on-going committees: the Disaster Council, composed of directors and managers of the San Francisco departments and agencies involved in emergency operations; and the Emergency Planning Committee, made up of staff members actively involved in emergency operations planning within the various departments.

There are essentially three levels of plans necessary for emergency disaster response in San Francisco:

1. Emergency Operations Plan: This basic plan establishes the legal authority for and gives the general operating procedures for emergency operations; it was last revised in March 1974.

2. Response Plans: These plans contain the methodology for responding to specific kinds of disasters. San Francisco has four such plans:

    a. San Francisco Nuclear Emergency Operations Plan

    b. Oil and Hazardous Materials Pollution Control Plan

    c. Emergency Evaluation Plan

    d. Bay Area Earthquake Response Plan (in final preparation)

3. Functional Emergency Plans: These are the specific in-house department or agency emergency plans, telling who does what and when. Many of the existing functional emergency plans are inadequate and must be revised, in light of new earthquake hazard information, and the new organizational structure developed for the Earthquake Response Plan.

Some of the principal activities of the SF/OES are coordination of Mutual Aid Agreements, development of text exercises, coordination of Functional Emergency Plans, education of the public, and procurement of surplus supplies and equipment.

The SF/OES is responsible for drafting and coordinating certain plans, and is also looked to by other City departments for guidance, for incentives and for assistance in developing their own plans.

Emergency operations historically has been and continues to be a low-priority item in San Francisco. The SF/OES has had to deal with a high degree of apathy, and in turn with a low degree of funding and other support.

Nevertheless, many shortcomings can be corrected with existing resources. Increased awareness of geologic hazards in San Francisco, plus new legislation strengthening safety standards in the State, will allow the SF/OES to become more of an emergency planning agency than it has been in the past.

Physical Sites and Facilities

The Emergency Operations Center (EOC), presently in the basement of the Youth Guidance Center, is the most vital physical element in interdepartmental emergency operations planning. This facility is inadequate -- too small, ill-equipped and virtually unprotected

A multi-purpose building is required, one which would house all the day-to-day emergency operations centers of the City -- fire, police, ambulance dispatchers and others -- and the facilities of the SF/OES: a building with which the operating staff would be familiar. The building should be one that is used on a daily basis and merely up-staffed in the event of a major disaster. Many obstacles stand in the way of such a new EOC. A more detailed background discussion of the EOC is contained in paper #4 EMERGENCY OPERATIONS CENTER.

San Francisco is now divided, under the Bay Area Earthquake Response Plan, into ten Districts for internal emergency planning purposes; these Districts correspond to the existing Fire Battalion Districts. Within each District there are four key emergency operations components:

1. District Headquarters: A central facility within each District, with communications capability to and from the EOC. The Fire Battalion District Headquarters in each District have been tentatively designated as emergency operations District Headquarters.

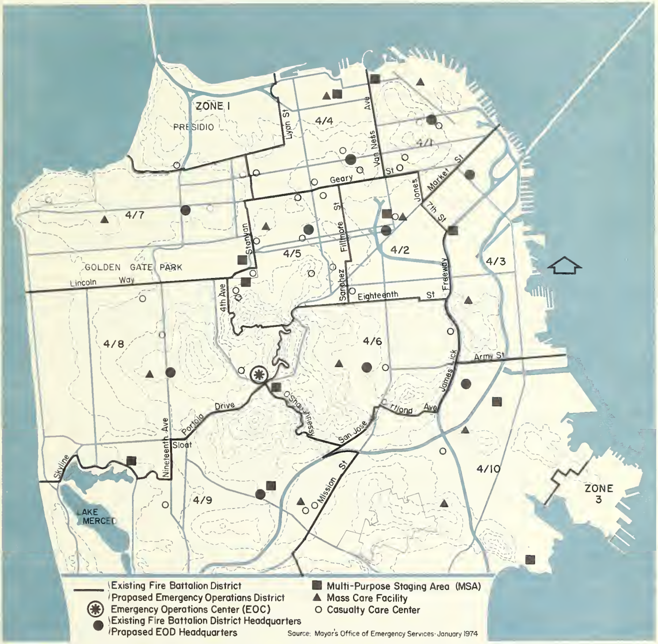
2. Mass Care Facility: A site from which lodging, feeding, clothing, registration, first aid, welfare inquiry and essential social services can be provided to disaster victims during the immediate post-disaster period.

3. Multi-Purpose Staging Area: A pre-designated site having a large parking area and shelter for equipment and personnel. It is also a rallying point for Mutual Aid.

4. Casualty Care Center: A major first aid and medical care site.

The selection of these four key centers in each District should be a careful, deliberate action as the role they play in emergency activities is critical.

Many of the presently proposed sites are potentially hazardous in the event of a disaster The site designations are preliminary and careful evaluation of each site is needed, considering each according to such criteria as susceptability to geologic hazards, structural integrity, debris clearance ability, staff parking, and the physical relationship of the District Headquarters to other emergency facilities and sites.



Source: Mayor's Office of Emergency Services · January 1974

PRELIMINARY PROPOSED EMERGENCY OPERATIONS DISTRICTS AND FACILITIES, ZONE 4

Experiences in all recent natural disasters, including the San Fernando earthquake of 1971, demonstrate there is no single factor more important to a coordinated emergency operations system than a usable disaster communications network which effectively links essential, on-the-scene emergency services.

Some individual agency communications systems of the City are well-advanced and adequately serve in-house, day-to-day communications needs. These same systems may also serve the agency's emergency operations needs (though few agencies hold test exercises in such operations). However, communications among the operating service agencies are also required, and in this area capability is severely limited.

The overall coordination of emergency communications for optimum efficiency would take place from the Emergency Operations Center. The present EOC is lacking in radio communications equipment; its principal communications capability is dependant upon a groundline telephone system that would be very susceptible to earthquake damage.

A specific evaluation of San Francisco Emergency Communications requirements and preparedness for both organization and equipment is critically needed. Each agency which will play a role in emergency operations must have an adequate day-to-day in-house radio communications system, and all of these systems must be tied into one interdepartmental emergency system linked to the Emergency Operations Center.

In conclusion, some of San Francisco's emergency operations planning is in excellent shape. The Federal Government is providing funding for disaster preparedness; the State has granted legal authority for such activity; the City Charter and Administrative Code establish emergency powers; there is an Office of Emergency Services within the Mayor's Office as well as a coordinating Disaster Council comprised of departmental directors and managers. A good Basic Plan exists; a new regional Bay Area Earthquake Response Plan is near completion. The groundwork has been laid for a good emergency planning network.

There is less than optimum present ability to implement emergency operations plans. Three key deficiencies -- out-of-date Functional Emergency Plans, an inadequate Emergency Operations Center, and certain communications plan deficiencies -- plus the lack of more extensive test exercises, present the greatest obstacles to effective emergency operations preparedness in San Francisco. Except for a new Emergency Operations Center, the solutions to the existing inadequacies in many instances are neither difficult nor costly.

Fire-Fighting Capability

San Francisco is protected from recurrence of a disastrous fire such as took place in 1906 in a number of ways: City Charter provisions, Building Code provisions, Fire Code provisions, standard City operating policies, and the maintenance of extensive fire-fighting water supply systems.

City Charter provisions empower the Fire Department to approve or deny building permits, prosecute hazard abatement proceedings and to remove structures to check conflagration.

The Building Code attempts to insure safety of life and property from fire through (a) designation of City fire districts; (b) provisions regarding combustability of building materials; (c) property-line fire protection regulations; (d) minimum exit requirements, including those regarding fire stairs; (e) requirements for access for fire-fighting; (f) fire detection and extinguishing systems requirements; (g) requirements regarding occupancy; (h) regulations regarding minimum widths of fronting streets; and (i) life safety programs for high-rise buildings.

The Fire Code contains key provisions regarding fire prevention and inspection, flammable materials, special occupancy and hazard requirements, protection and prevention of obstruction of fire-fighting water supply systems, and exit requirements.

Operating policies within City agencies assure Fire Department review of proposed subdivision and other major projects at an early stage in order to insure fire-fighting capability.

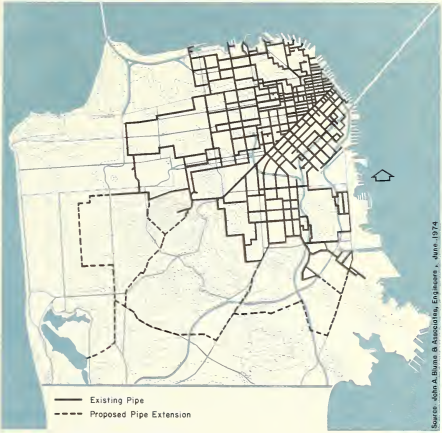
San Francisco's fire-fighting water supply capability relies on two separate systems: the Auxiliary Water Supply System (AWSS) and the domestic water supply system.

The AWSS is the primary fire protection water supply system for downtown San Francisco. It is a high-pressure system with its own reservoir (Twin Peaks Reservoir), 150 cisterns at key intersections and two pumping stations on the Bay. It is constructed to high standards and includes such safety features as emergency shut-off valves in the areas of the city susceptible to pipe breakage.

However, this system only protects a relatively small part of the city. There are plans to expand a single line of this system from the Richmond District, through the Sunset District, east along Ocean Avenue and south along both Mission and Third Streets. The extension would serve primarily to create fire breaks to seal off certain districts of the city in the event of a major conflagration.

The primary fire-fighting water supply in areas of San Francisco not protected by the AWSS is the domestic water system. Although providing an adequate supply under normal conditions, parts of the system may fail in the event of an earthquake; much of the system is of brittle construction without flexible joints. The same system sustained 23,000 line breaks in 1906, mostly at house connections, creating a sieve-like condition throughout the city.

The cost of a total replacement of the older domestic water supply pipes with newer, more flexible pipes and joints is virtually prohibitive. However, any expansion of the domestic system by the Water Department could conform to standards of the Fire Department and, any opportunities for incremental replacement of the old pipes could significantly improve the reliability of this system for fire-fighting purposes.



Source: John A. Blume & Associates, Engineers, June 1974

AUXILIARY WATER SUPPLY SYSTEM

POST-DISASTER RECONSTRUCTION

Adequate preparation to safeguard lives and property threatened by a major disaster requires many varied and wide-ranging activities. The advance consideration of what must be done after a major disaster is an equally important area of need. The experience of other cities which have experienced major earthquake damage such as Anchorage, Alaska points to the overwhelming necessity of having established methods for guiding post-earthquake reconstruction. When advance preparation is not made, serious problems inevitability arise. For instance, once a disaster has occurred and capital becomes available, rapid reconstruction becomes not only desired but possible; at that time, the task of local officials in controlling and administering the reconstruction to avoid repetition of proven past mistakes becomes extremely difficult. An in-depth examination of sources of public capital assistance and implications for reconstruction is contained in background paper #3, POST-DISASTER FINANCIAL ASSISTANCE.

Following a disaster there usually occurs a general spirit of "let's rebuild it right". However, with the availability of capital expediency becomes the primary motivation and certain agencies and departments of the City, particularly the Bureau of Building Inspection and Department of City Planning, will tend to be overwhelmed by pressure to lower standards and regulations in order not to impede reconstruction. This was the case in Anchorage, Alaska, where reconstruction has taken place on the same hazardous sites; this must be prevented in San Francisco so that rebuilding can take place in a rational manner, with the quality and safety of development better, not worse, than before.

This rational reconstruction will take place only if thorough consideration is given to the impact of a specific disaster; in turn, a determination of what preparation and actions would be appropriate prior to the occurrance of an earthquake is needed. This may be done, in part, through an evaluation of the experiences of other cities, estimation of areas of potential damage, and an estimation of resources and processes that are needed to properly guide and control reconstruction.

In a positive sense, post-earthquake reconstruction presents opportunities to affect actions and changes not possible prior to extensive damage; these opportunities would be related to transportation systems, land uses, building sizes and heights, location and connection of open space systems, and other factors. Properly directed reconstruction can provide the means for long needed improvements while correcting or eliminating past mistakes.

Much of this may be accomplished by rebuilding in accordance with established Master Plan objectives and policies. Alternative land-use studies for reconstruction of the City could be made in advance, based upon estimates of possible major damage. Transit and transportation systems and possible modification of street patterns should also be studied for possible implementation. In addition, development of emergency Building Code provisions and land-use plans for temporary uses would help ease the pressures for excessively rapid redevelopment.

The control or regulation of capital available for reconstruction is another approach to reduce pressure for lowering building and planning standards. Special conditions placed on the granting of funds for reconstruction by the issuing agency, and special provisions by local government for the administration of reconstruction projects can do much to reduce the pressure to eliminate or circumvent existing codes and procedures. Regulation of building materials with priorities assigned to projects of greater public need might be considered.

Evidence of an approved building permit could be required as part of the application for any Federal financial assistance for reconstruction. The integration of private financial institutions into such a process would also be important. Financial aid programs should also be flexible enough to allow funding for rebuilding damaged structures in new, safer locations if their existing locations have been found to be geologically hazardous.

It is essential that reconstruction needs be acknowledged in advance and steps taken to prepare appropriate responses. The first step might be the appointment of a committee to thoroughly evaluate the problems and determine the needed actions and resources. Such a committee could include a broad base of representation from both the private and public sectors and bring together those who will play major roles in the reconstruction of San Francisco.

If reconstruction is to be rational and orderly, needed actions must be thought out, preparations made, and contingency legislation drafted and enacted prior to a major earthquake in order to insure that the rebuilding of San Francisco is not merely a duplication or aggravation of previous errors.

LIFE SAFETY/LEVEL OF RISK

Seismic investigations conducted for San Francsico have documented geologic and structural hazards, emergency operations planning needs and post-disaster reconstruction implications. In each area of investigation there were found to be very important life safety considerations which must be considered.

It is important to remember that absolute life safety assurance is an impossibility. There are always risks, presented by everything from the natural environment: hurricanes, lightning, floods, earthquakes -- to the behavior of man: hit-and-run driving, criminal assault, poor building construction.

In an area of seismic hazards, the risks are mainly from structural failure. This includes a wide range of risks with different types of effects. One might be hit by a falling parapet while walking along a sidewalk; a building might collapse while filled with people. Objects falling inside or outside buildings; or the failure of mechanical systems are also hazards not necessarily generated by structural failure.

Sometimes it is not necessarily the structure that one is in, or near, that presents the potential risk often the risk is presented by the potential failure of a critical lifeline system -- the domestic water supply system is ruptured and there is no fire-fighting capability; the failure of mechanical equipment in a hospital endangers lives; highways collapse or streets are filled with debris, preventing emergency vehicle access to critical facilities.

All of these situations represent varying degrees of danger dependent upon where and how structures of the city are built relative to the underlying geology. The varying degrees of danger, in turn, present varying degrees of risk to individuals or the community.

The ideal goal would be to eliminate all dangers and thus, all risk. As in other facets of life, this would not be physically, socially, or economically feasible. Therefore, the objective is to minimize the dangers in a way which balances the degree of risk with the accompanying costs of reducing that risk. Varying degrees of risk are acceptable, or unacceptable, for different situations, and for different reasons. A minimum level (or levels) of risk from earthquakes, acceptable to the public, needs to be determined.

There are alternative methods for establishing minimum levels of risk; however, certain key factors are common to all of these methods. Key concerns are the importance of a function or use to the general welfare of the community; the intensity of use or density of occupancy (that is, the number of lives exposed to a potential hazard); whether the exposure to the risk is a voluntary or involuntary action; and the economic factors determining the costs the community is willing, or able, to bear to reduce the risk.

A basic level, or highest degree of acceptable risk that has been set in many communities requires that there be no structural collapse endangering lives. This level coincides with the basic philosophy and standards of the present San Francisco Building Code.

Included at the opposite end of a scale of acceptable levels of risk would be those structures that should be subject to the least degree risk attainable. This would include structures whose function or use is so important to the general well-being of the community that virtually any cost should be borne in order to assure the structures' operational capability after a disaster, that the structure must not collapse and must be fully functional after an earthquake. Examples of this level are key emergency operations facilities such as the Emergency Operations Center, Twin Peaks fire-fighting reservoir, the emergency ambulance dispatch center, and public record storage facilities. The most important structures to the community safety and well-being would be in this category. This least degree of risk for critical facilities and the highest degree, as in the basic or threshold level, should form the two extremes of risk that the public should bear.

Between the highest and least risk levels could fall one or more intermediate levels or categories of risk that would apply to structures which have high occupancy densities, involuntary exposure to the danger, or necessity for use after a disaster. Typical examples of these would be churches, schools, police stations and theatres. In general, the use (and density of occupancy) of a structure will determine the acceptable level of risk to which a structure would be subject.

Public codes regulating structures, whether at State or local levels, in effect establish a minimum level, or degree, of acceptable risk. These codes establish regulations for all types of structures. Sometimes they are related to use, but seldom are they related to the importance of a structure to the general welfare, especially in time of emergency, or to a specific hazard such as earthquakes. Some special legislation has acknowledged these kinds of concerns -- the Field Act for the structural safety of schools and more recently the State of California requirements that hospitals must be not only structually sound following an earthquake, but must remain operational as well.

Operational capability is an important consideration that goes beyond normal provisions regulating structural design. Other considerations related to operation and safety are for mechanical equipment, architectural finishes and furnishings. Extensive movement of files, desks or furniture can also seriously endanger lives and impair operational capability.

There is a public responsibility, as precedent has established, to define discrete levels of acceptable risk for certain structures whose operational capability is important to the general welfare or where other specific concerns are present.

HAZARD ABATEMENT

The structural investigation identified areas of San Francisco in which there are existing structures with a potential high degree of risk: the areas of potentially severe structural damage. The sites of a building type particularly susceptible to earthquakes, pre-1948 Type C buildings, were also identified and mapped. In addition, the geologic investigation identified areas of potentially high geologic risk. In all of these areas appropriate hazard abatement actions are needed.

A funcamental goal of the Community Safety Element is the reduction of hazards to life and property from earthquakes in San Francisco. The development of hazard abatement programs to meet this objective can be based upon adopted levels of acceptable risk.

A hazardous structure might be defined as any structure whose use is inconsistent with the levels of acceptable risk. Priorities for hazard abatement could then be established according to the importance of the structure to the community, and the number of people exposed to unacceptable risks.

Another facet of hazard abatement actions is the effects they may have on the appearance of San Francisco. Such actions will, as a matter of course, affect primarily older structures. Many of these structures are the same ones that give San Francisco much of its charm and character.

Efforts to reduce hazards could easily result in building demolitions, architectural and ornamental building element removal or extensive building facade renovation. The loss or alteration of many buildings could drastically change the unique visual appearance of the city. These concerns were examined in background paper #2 SAN FRANCISCO PARAPET ORDINANCE as directly related to enforcement of that existing ordinance for abatement of hazards. Similar kinds of concerns must be considered in programs to effect abatement of other hazards from existing buildings.

SUMMARY OF OBJECTIVES AND POLICIES

LIFE SAFETY

OBJECTIVE 1: REDUCE HAZARDS TO LIFE SAFETY, AND MINIMIZE PROPERTY DAMAGE~~,~~ AND ECONOMIC DISLOCATIONS RESULTING FROM FUTURE EARTHQUAKES.

POLICY 1. APPLY A MINIMUM LEVEL OF ACCEPTABLE RISK TO STRUCTURES AND USES OF LAND BASED UPON THE NATURE OF USE, IMPORTANCE OF THE USE TO PUBLIC SAFETY AND WELFARE, AND DENSITY OF OCCUPANCY.

POLICY 2: INITIATE ORDERLY ABATEMENT OF HAZARDS FROM EXISTING BUILDINGS AND STRUCTURES.

IN FACILITIES

POLICY 3: ABATE EXISTING HAZARDS IN ALL CRITICAL COMMUNITY FACILITIES~~;~~ WHERE IT IS NOT FEASIBLE TO ABATE HAZARDS ~~TO~~ EXISTING FACILITIES IN SPECIAL GEOLOGIC STUDY AREAS, MOVE THE~~M~~ TO NEW SAFER LOCATIONS; LIMIT LOCATION OF NEW FACILITIES TO SITES OUTSIDE SPECIAL GEOLOGIC STUDY AREAS UNLESS NO VIABLE ALTERNATIVE EXISTS.

POLICY 5: MODIFY PERMITTED LAND USES AND TYPES OF STRUCTURES, WHERE APPROPRIATE, ACCORDING TO GEOLOGIC FACTORS AND CONSISTENT WITH THE LEVELS OF ACCEPTABLE RISK.

POLICY 4: REQUIRE GEOLOGIC AND ~~OR~~ SOIL ENGINEERING SITE INVESTIGATIONS, AND COMPENSATING STRUCTURAL DESIGN BASED ON FINDINGS, FOR ~~ALL~~ NEW STRUCTURES IN SPECIAL GEOLOGIC STUDY AREAS.

POLICY 6: REVIEW AND AMEND AT REGULAR INTERVALS ALL RELEVANT PUBLIC CODES TO INCORPORATE THE MOST CURRENT KNOWLEDGE AND HIGHEST STANDARDS OF SEISMIC DESIGN.

POLICY 7: SUPPORT SEISMIC RESEARCH THROUGH APPROPRIATE ACTIONS BY ALL PUBLIC AGENCIES.

PRESERVATION

OBJECTIVE 2: PRESERVE, CONSISTENT WITH LIFE SAFETY CONSIDERATIONS, THE ARCHITECTURAL CHARACTER OF BUILDINGS AND STRUCTURES IMPORTANT TO THE UNIQUE VISUAL IMAGE OF SAN FRANCISCO.

POLICY 1: RETAIN THE ARCHITECTURAL DESIGN CHARACTER OF BUILDINGS AND STRUCTURES IN THE RENOVATION WORK REQUIRED FOR ABATEMENT OF HAZARDS TO LIFE SAFETY.

EMERGENCY OPERATIONS

OBJECTIVE 3: ENSURE THE PROTECTION OF LIFE AND PROPERTY FROM THE EFFECTS OF FIRE OR NATURAL DISASTER THROUGH ADEQUATE EMERGENCY OPERATIONS PREPARATION.

POLICY 1: MAINTAIN A LOCAL AGENCY FOR THE PROVISION OF EMERGENCY SERVICES TO MEET THE NEEDS OF SAN FRANCISCO.

POLICY 2: DEVELOP AND MAINTAIN VIABLE, UP-TO-DATE DEPARTMENTAL EMERGENCY OPERATIONS PLANS, WITH NECESSARY EQUIPMENT, ~~FOR~~ TO ASSURE OPERATIONAL CAPABILITY OF ALL EMERGENCY SERVICE AGENCIES AND DEPARTMENTS.

POLICY 3: MAINTAIN AND EXPAND AGREEMENTS FOR EMERGENCY ASSISTANCE FROM OTHER JURISDICTIONS TO ENSURE ADEQUATE AID IN TIME OF NEED.

POLICY 4: ESTABLISH AND MAINTAIN AN ADEQUATE EMERGENCY OPERATIONS CENTER.

POLICY 5: MAINTAIN AND EXPAND THE CITY'S FIRE-PREVENTION AND FIRE-FIGHTING CAPABILITY.

POLICY 6: ESTABLISH ~~A~~ AND MAINTAIN SYSTEM OF EMERGENCY ACCESS ROUTES FOR BOTH EMERGENCY OPERATION~~S~~ AND EVACUATION NEEDS.

POLICY 7: PROVIDE CONTINUING PUBLIC EDUCATION REGARDING EMERGENCY PROCEDURES.

RECONSTRUCTION

OBJECTIVE 4: ASSURE THE SOUND AND RATIONAL RECONSTRUCTION OF SAN FRANCISCO FOLLOWING A MAJOR DISASTER.

POLICY 1: MAINTAIN THE SOUND AND RATIONAL REDEVELOPMENT OF SAN FRANCISCO~~,~~ FOLLOWING A MAJOR DISASTER~~,~~ BY REBUILDING IN ACCORDANCE WITH ESTABLISHED COMPREHENSIVE PLAN OBJECTIVES AND POLICIES, APPROPRIATE CITY CODES, AND OTHER COMMUNITY CONCERNS AND NEEDS.

POLICY 2: ADOPT CONTINGENCY LEGISLATION, TO PROVIDE FOR ANTICIPATED NEEDS FOLLOWING A MAJOR DISASTER,AND TO REDUCE PRESSURES FOR UNNECESSARILY RAPID RECONSTRUCTION.

POLICY 3: CREATE A RECONSTRUCTION PLANNING COMMITTEE TO INSURE THAT DEVELOPMENT FOLLOWING A MAJOR DISASTER TAKES PLACE IN A TIMELY FASHION ACCORDING TO ESTABLISHED OBJECTIVES, ~~AND~~ POLICIES, AND PROCEDURES

OBJECTIVES AND POLICIES

LIFE SAFETY

OBJECTIVE 1:

REDUCE HAZARDS TO LIFE SAFETY, MINIMIZE PROPERTY DAMAGE, AND ECONOMIC DISLOCATIONS RESULTING FROM FUTURE EARTHQUAKES.

San Francisco is surrounded by major active faults. Future earthquakes capable of producing great damage and disaster are inevitable. In the broadest sense, the works of man are the principal earthquake hazards. Damage to structures subjected to ground shaking caused by earthquakes will present hazards to life safety and the economic well-being of the community.

Much is known about the resistance of structures to damage, and the ways to minimize damage, of various types of structures subject to earthquake forces. Existing technology is such that structures can be designed that are very resistant to damage from earthquake forces and will remain both structurally and operationally sound following an earthquake.

Many existing structures in San Francisco may suffer considerable damage from a major earthquake; others may suffer little or no structural damage but could be functionally inoperative. The possibility of general structure failure presents great hazard to life safety, and the operational failure of structures such as hospitals or emergency operations facilities poses an even greater degree of hazard to the community at large.

It is not possible to prevent, control, or accurately predict the time of occurrence of earthquakes. It is, therefore, important to minimize hazards to life safety and property damage in existing and new structures relative to the degree of hazard present and ~~their~~ importance of the structures to the well-being of the community.

POLICY 1

APPLY A MINIMUM LEVEL OF ACCEPTABLE RISK TO STRUCTURES AND USES OF LAND BASED UPON THE NATURE OF USE, IMPORTANCE OF THE USE TO PUBLIC SAFETY AND WELFARE, AND DENSITY OF OCCUPANCY.

It is not possible to eliminate all risks to life or property ~~from earthquake-caused damage~~ in areas of high seismic activity. Stringent construction standards could be applied to achieve a very low level of risk; however, these could result in unbearably high social or economic costs to the community.

The application of performance standards related to the ~~type~~ degree of risk can result in a level of minimum risk appropriate to the use of each structure being considered. There has already been a public determination of a level of acceptable risk for schools and hospitals. This concept should be expanded to apply to all structures.

The determination of a level of acceptable risk should be based upon the importance of a structure to the general welfare of the community (such as hospitals), the hazard a particular use may present to the larger community (the storage of volatile goods), the intensity of use, or the density of occupancy (such as theatres, schools, and office buildings or apartments); and whether exposure to risk is a voluntary or involuntary action (as in stores, convalescent hospitals, jails). The acceptable level of risk for each type of structure must ultimately be determined by the cost the community is willing or able to ~~expend.~~ incur

Public codes, especially the City Planning Code and the Building Code, regulate land uses and set minimum standards for construction of buildings and other structures. These codes ~~are for the purpose of~~ provid~~ing~~e for the general public health, safety and welfare. Amendments, where necessary, should be made to these regulatory codes to incorporate requirements needed to effect levels of acceptable risk for all structures and uses. When feasible these amendments should be retroactive to serve as the basis for hazard abatement programs, especially for critical community facilities.

The following three classifications of criteria should be used to determine standards to achieve the minimum level of acceptable risk for all structures:

RISK LEVEL 1

- No structural collapse should occur.
- Damage may occur to interior or exterior finishes, mechanical systems, or to contents of structure.
- Applies generally to low-density, voluntary occupancy structures of wood-frame, Type 5, construction for which there is no critical community need:
    - single-family homes
    - two-family homes
    - apartment buildings
    - warehouses
    - stores
    - industrial buildings

RISK LEVEL 2

- No structural collapse or mechanical failure should occur that could cause loss of life.
- Mechanical systems may fail to operate but failure of mechanical or architectural elements such as light fixtures, pipes or ducts, suspended ceilings, or elevators should not cause loss of life.
- Failure of mechanical systems should be limited to that which can be quickly repaired with minimal outside assistance.
- Damage may occur to interior or exterior finishes or to contents of structures.
- ~~No damage that would preclude rapid restoration to operational capability should occur.~~
- Applies generally to structures of medium-to-high-density occupancy and structures whose use following a disaster might be desirable but not critical.
  - large stores
  - theatres and other places of public assembly
  - office buildings
  - large apartment buildings or complexes
  - large hotels
  - police stations
  - schools
  - jails and detention centers
  - dormitories
  - convalescent hospitals

RISK LEVEL 3

- No structural collapse or mechanical failure that would cause the ~~buildi~~ facility to be inoperative.
- Little or no damage to interior furnishings and equipment.
- Must be ~~fully~~ operational ~~immediately~~ following a major earthquake.
- Applies generally to all structures which are critical community facilities, or whose failure would present great hazards to the community.
  - emergency operations facilities
  - emergency operations center
  - central radio station
  - central fire alarm station
  - Police Dispatch Headquarters
  - Fire Battalion Distric Headquarters
  - hospitals
  - water reservoirs
  - gas or oil storage tanks
  - bridges
  - public records storage structures

POLICY 2:

INITIATE ORDERLY ABATEMENT OF HAZARDS FROM EXISTING BUILDINGS AND STRUCTURES.

Existing hazardous buildings and structures represent a threat to the lives and safety of the community that should not be continued. Actions should be taken to identify these structures, and abatement of the hazards should commence at the earliest possible time. Priority for identification and abatement of hazards should be given to: (1) areas with high concentrations of potentially hazardous Pre-Code, Type C buildings; (2) areas with high population densities, and (3) those structures for which there is a critical community need.

POLICY 3:

ABATE EXISTING HAZARDS IN ALL CRITICAL COMMUNITY FACILITIES; WHERE IT IS NOT FEASIBLE TO ABATE HAZARDS TO EXISTING FACILITIES IN SPECIAL GEOLOGIC STUDY AREAS, MOVE THEM TO NEW SAFER LOCATIONS; LIMIT LOCATION OF NEW FACILITIES TO SITES OUTSIDE SPECIAL GEOLOGIC STUDY AREAS UNLESS NO VIABLE ALTERNATIVE EXISTS.

Special attention should ~~also~~ be given to the critical facilities that are presently ~~located~~ in areas of potential ground movement or inundation hazard. If compensation cannot be made to assure their function, consistent with their community importance, they should be moved to new, safer locations.

Sites for new critical community facilities should be very carefully selected. The site selection process should seek to minimize hazards to the operation of the facility and the costs that are required for proper construction. To achieve this, priority for selection of sites should be given to locations outside of Special Geologic Study Areas. If sites within the special study areas would be especially advantageous, special engineering design should be included to assure that identified risks have been ameliorated.

POLICY 4:

REQUIRE GEOLOGIC ~~OR~~ AND SOIL ENGINEERING SITE INVESTIGATIONS, AND COMPENSATING STRUCTURAL DESIGN BASED ON FINDINGS, FOR ALL NEW STRUCTURES IN SPECIAL GEOLOGIC STUDY AREAS.

The Special Geologic Study Areas include all areas of San Francisco in which one or more potential geologic hazards exist. Potential land movement hazards, potential inundation hazards, or both, may be present for any site within these areas. Special site investigations should be required in these potential hazard areas to determine the actual hazard, if any, for all proposed new development. Based upon the finding of the site investigation and determination of type and degree of hazard present, appropriate engineering design should be required to ameliorate the hazard. If proper engineering design is not technically or economically feasible, development of the site should not be permitted.

Increased concentrations of people in areas of potential geologic hazards increases the possibility of injury or loss of life. Special evaluations must be made to determine the appropriateness for expansion of existing uses in the Special Geologic Study Areas. Only if determination is made that adequate safety, consistent with the levels of acceptable risk, can be assured should expansion be allowed.

POLICY 5:

MODIFY PERMITTED LAND USES AND TYPES OF STRUCTURES, WHERE APPROPRIATE, ACCORDING TO GEOLOGIC FACTORS AND CONSISTENT WITH THE LEVELS OF ACCEPTABLE RISK.

Thorough integration of geologic factors ~~in~~ to the regulation of land and structures should be made to further protect life and property and assure the most positive relationship ~~of~~ between geologic environment and the types and uses of structures.

POLICY 6:

REVIEW AND AMEND AT REGULAR INTERVALS ALL RELEVANT PUBLIC CODES TO INCORPORATE THE MOST CURRENT KNOWLEDGE AND HIGHEST STANDARDS OF SEISMIC DESIGN.

It is essential to the public safety and welfare that codes regulating the construction of buildings and structures incorporate the latest knowledge and standards for seismic design. As practical application of this knowledge becomes possible it should be incorporated into appropriate codes. In particular, action should be taken to amend codes relative to improved standards for design of lifeline systems, impact of geologic environments on land uses, and inclusion of anticipated ground shaking factors in standards for engineering design of buildings and structures.

POLICY 7:

SUPPORT SEISMIC RESEARCH THROUGH APPROPRIATE ACTIONS BY ALL PUBLIC AGENCIES.

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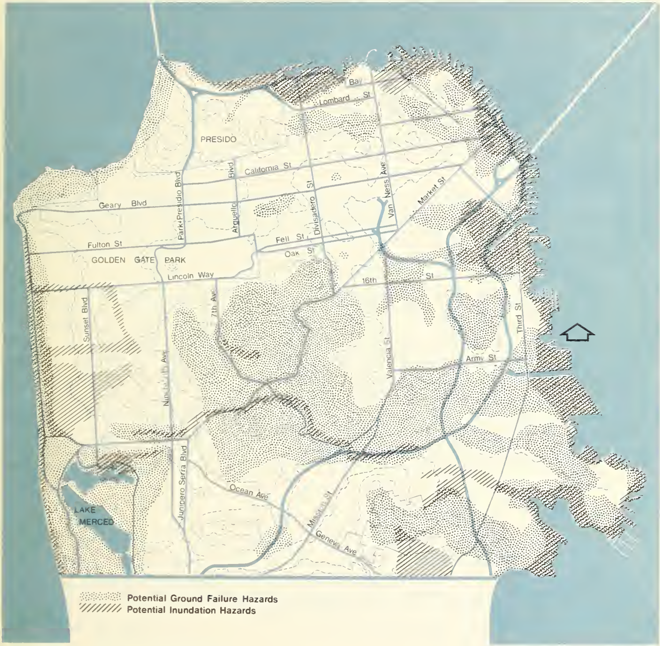
Understanding of earth movement forces, and in turn the ways they affect ~~the design of~~ structures, provides the means for improved design standards to better assure the public safety. For this reason the public interest is served through continuing and expanded research programs.

Public agencies should support existing seismic research programs and encourage new programs by appropriate actions in their area of responsibility. Particular efforts should be made to assure the ~~completion~~ and continued maintenance of the strong-motion instrumentation program in San Francisco.



SPECIAL GEOLOGIC STUDY AREAS

OBJECTIVE 2

PRESERVE, CONSISTENT WITH LIFE SAFETY CONSIDERATIONS, THE ARCHITECTURAL CHARACTER OF BUILDINGS AND STRUCTURES IMPORTANT TO THE UNIQUE VISUAL IMAGE OF SAN FRANCISCO.

The qualities that make San Francisco a special and unique city are many. One of those very important qualities is the style and design characteristics of the city's older buildings. Some of these date from the 1800's but most were built in the early 1900's. These buildings and structures, by present standards and knowledge of structural design, may present hazards to those who occupy them. It is important to eliminate life safety hazards that may be present in these older buildings, and it is equally important to retain those features of the design that significantly contribute to the special character of San Francisco.

POLICY 1

PRESERVE THE ARCHITECTURAL DESIGN CHARACTER OF BUILDINGS AND STRUCTURES SUBJECT TO REQUIREMENTS FOR ABATEMENT OF HAZARDS TO LIFE SAFETY.

The abatement of hazards to life safety will affect, primarily, the older structures in the city. Often the hazards presented by the structures are from those architectural design elements -- parapets, cornices, and other ornamentation -- that give each their own special character. In cases where remedial work is required to abate hazards from structures important to the character of San Francisco, every effort should be made by the owner and the city to assure the preservation of the architectural design of the structure. This should be accomplished through reinforcing, replacing or redesigning, in similar architectural style, those building elements which present a life safety hazard.

OBJECTIVE 3

ENSURE THE PROTECTION OF LIFE AND PROPERTY FROM THE EFFECTS OF FIRE OR NATURAL DISASTER THROUGH ADEQUATE EMERGENCY OPERATIONS PREPARATION.

Emergency operations planning and preparation are essentially preventive activities. The goals are saving lives, caring for the injured and re-establishing services that are essential to meet the immediate needs of the community. Although all critical emergency operations activities take place in the hours immediately after a disaster, the quality or success of these activities will be decided by the adequacy of pre-disaster planning and preparation.

POLICY 1

MAINTAIN A LOCAL AGENCY FOR THE PROVISION OF EMERGENCY SERVICES TO MEET THE NEEDS OF SAN FRANCISCO.

The key to effective organization for response to a natural disaster or any other emergency is the ability to accelerate and reinforce existing, practiced governmental functions. Effective emergency operations can take place only through coordination by a permanent public emergency services agency.

Emergency operations activities in San Francisco are the responsibility of the Mayor's Office of Emergency Services. This agency should be maintained and its capability expanded, as needed, to continue coordination of all emergency operations plans and activities. To assure adequate preparedness and operation capability, the agency should conduct, on a regular basis, all needed test exercises of the City's emergency preparations network -- emergency medical relief, emergency supply distribution, emergency communications capability, and other services. ~~The exercises should be conducted at the operational levels~~.

POLICY 2

DEVELOP AND MAINTAIN VIABLE, UP-TO-DATE IN-HOUSE EMERGENCY OPERATIONS PLANS, WITH NECESSARY EQUIPMENT, FOR OPERATIONAL CAPABILITY OF ALL EMERGENCY SERVICE AGENCIES AND DEPARTMENTS.

Agency and departmental emergency operations plans and standard operating procedures are ~~an~~ essential elements of an adequate municipal emergency operations system. These plans designate who is to perform specific actions; without them there can be little or no operational capability. The preparation of these plans should be the responsibility of the individual department or agency. To assist them the San Francisco Office of Emergency Services should develop criteria and guidelines for the preparation of the plans.

POLICY 3

MAINTAIN AND EXPAND AGREEMENTS FOR EMERGENCY ASSISTANCE FROM OTHER JURISDICTIONS TO ENSURE ADEQUATE AID IN TIME OF NEED.

San Francisco is able to receive assistance from other political jurisdictions after a disaster through its participation in the State Mutual Aid program, whereby each local jurisdiction relies first on its own resources; then, in accordance with prior formal agreements, calls for help from higher political jurisdictions as needed.

Mutual Aid should, and legally can be, expanded to include agreements regarding the sharing of personnel, such as the staffs of other public works departments, as well as equipment.

Mutual aid assistance programs should be continued, and where appropriate expanded; and the necessary actions, to the point of State or local legislation, should be taken to assure this.

POLICY 4

ESTABLISH AND MAINTAIN AN ADEQUATE EMERGENCY OPERATIONS CENTER.

An Emergency Operations Center (EOC) is the ~~central~~ protected, central facility to be used as a working base for directing and controlling emergency operations following a disaster. It should be a multi-purpose facility which houses the normal, day-to-day emergency services of the city -- police communications, fire alarm dispatch center, ambulance dispatch center and others -- and should be capable of being easily up-staffed in the event of a major disaster. It is the most important emergency operations facility

POLICY 5

MAINTAIN AND EXPAND THE CITY's FIRE PREVENTION AND FIRE-FIGHTING CAPABILITY

San Francisco insures fire safety and is protected from conflagration by City Charter provisions, Building Code provisions, Fire Code provisions and standard City operating policies.

The water supply capability for fire-fighting relies on two separate systems: the Auxiliary Water Supply System (AWSS) and the domestic water supply system. The AWSS, a high~~er~~ pressure system, ~~fire-fighting,~~ is the primary fire protection water supply ~~system~~ for downtown San Francisco. Planned ~~E~~expansion of a single line of the system through the western, southern and eastern districts of the City, to create "fire break" capability in the event of a major conflagration should be undertaken as rapidly as possible.

The domestic water supply system is used for fighting fires in all areas of the city not covered by the AWSS. Any expansion of the domestic water supply system should conform to the most advanced standards for seismic construction; and any opportunity for replacement of the older parts of the system should be taken.

The key to adequate water supply systems, and fire safety programs such as fire inspection, is regular on-going funding for equipment maintenance and programs ~~maintenance~~. Funding for new equipment, fire houses and other capital expenses has consistently been provided in San Francisco; adequate funding should also be provided to assure high levels of maintenance ~~for~~ of facilities and equipment and ~~for of~~ for fire prevention programs.

POLICY 6

ESTABLISH A SYSTEM OF EMERGENCY ACCESS ROUTES FOR BOTH EMERGENCY OPERATIONS AND EVACUATION.

If a major earthquake were to occur, debris from damaged buildings and other structures would clutter, and in many cases block, principal transportation routes. This is especially likely to happen in the Market - Van Ness - San Francisco Bay triangle area and south of Market Street. Routes made impassable by debris would limit access to key emergency operations facilities and sites, and would impair fire and rescue operations.

Primary and alternate emergency routes should be designated; selection criteria should include topography, geologic hazards, street widths, population density and potential inundation areas.

These emergency routes should serve both emergency access needs and the need for evacuation of areas subject to possible inundation from tsunami or reservoir failure. The routes to critical emergency facilities and sites will frequently differ from the routes which evacuate residents from a hazard area; thus the criteria for establishing these routes may also differ.

POLICY 7

PROVIDE CONTINUING PUBLIC EDUCATION REGARDING EMERGENCY PROCEDURES.

A comprehensive public education program regarding earthquakes and other natural hazards should be developed. It should provide information about the nature of earthquakes, about the many relatively simple and inexpensive precautions that can be taken before an earthquake to minimize individual injury and property damage, and about the kind of actions to take during and immediately after an earthquake to increase personal safety. Publicity through the media is important and continuing education and instruction should be undertaken through the public schools, Red Cross courses for adults, and programs with community groups and organizations.

OBJECTIVE 4

ASSURE THE SOUND AND RATIONAL RECONSTRUCTION OF SAN FRANCISCO FOLLOWING A MAJOR DISASTER.

A major disaster resulting in extensive destruction of many parts of the city will result in a public and private commitment to rebuild San Francisco. This ~~It will be~~ desire~~d~~ to rebuild as rapidly as possible will~~, this in turn is~~ likely ~~to~~ lead to overwhelming pressure to overlook established development objectives and procedures

On a continuing basis, public regulations and policies have been instituted to further the development of San Francisco in a sound and rational manner. In rebuilding it is imperative that established life safety procedures be observed, and that reconstruction of the destroyed areas takes full advantage of the opportunity to effect improvements to the City. ~~Proper planning prior to a disaster can assure the sound and rational reconstruction of San Francisco.~~

POLICY 1

MAINTAIN THE SOUND AND RATIONAL DEVELOPMENT OF SAN FRANCISCO, FOLLOWING A MAJOR DISASTER, BY REBUILDING IN ACCORDANCE WITH ESTABLISHED COMPREHENSIVE PLAN OBJECTIVES AND POLICIES, APPROPRIATE CITY CODES, AND OTHER COMMUNITY CONCERNS AND NEEDS.

The Comprehensive Plan and numerous City codes have been adopted to assure the preservation, ~~and~~ enhancement, and ~~the~~ safety of this very desirable urban environment. Following a major disaster, the normal functioning of the City will be disrupted. In the efforts to restore the City, ~~all~~ existing development policies and regulations must be enforced. The existing policies, regulations, and procedures should not be lessened or circumvented in any manner as the result of pressures for rapid reconstruction.

In those areas that will be reconstructed the opportunity should be taken to realize the objectives and policies of the Comprehensive Plan. Particular opportunities may exist for residential and multiple use development; for needed changes or modification to transit and traffic ways systems; and provision of much needed public and private open space.

POLICY 2

ADOPT CONTINGENCY LEGISLATION TO PROVIDE FOR ANTICIPATED NEEDS FOLLOWING A DISASTER AND TO REDUCE PRESSURES FOR UNNECESSARILY RAPID RECONSTRUCTION.

New legislation will be required to meet the special needs of the City during the reconstruction period. Although it is essential that existing processes be observed during reconstruction, many special services and facilities will be needed on a short-term basis. Particular consideration should be given to legislation related to: provisions for temporary housing, commercial, and community facilities needs; appropriate amendments to the Planning Code, especially to limit reconstruction of non-conforming uses; establishment of priorities for the use of limited resources such as building materials and labor; and assurance of adequate staffing of City agencies to provide for community needs during reconstruction. Automatic expiration dates should be considered for all legislation enacted in response to reconstruction needs.

POLICY 3

CREATE A RECONSTRUCTION PLANNING COMMITTEE TO INSURE THAT DEVELOPMENT FOLLOWING A MAJOR DISASTER TAKES PLACE IN A TIMELY FASHION ACCORDING TO ESTABLISHED OBJECTIVES AND PROCEDURES.

In order to minimize disruption ~~to~~ of City functions, assure viable direction and coordination of reconstruction and ~~in general~~ expedite the sound and rational reconstruction of San Francisco, an Advisory Reconstruction Planning Committee should be appointed. The charge of the Committee would be to formulate strategies and make recommendations for actions that should be taken in advance of and following a major disaster to appropriately guide reconstruction efforts. The Committee should be established at the earliest feasible time through joint action by the Mayor and the Board of Supervisors. The Department of City Planning should be responsible for the coordination of the work undertaken by the Committee.

Appointments to the Committee should include, but should not be limited to representatives of: the Mayor's Office; Board of Supervisors; Department of City Planning; Department of Public Works; Office of Emergency Services; Federal, State, and local governmental and private organizations providing (1) financial assistance, (2) medical, housing, and social services, and (3) transportation and transit services; public utilities; labor; business and finance; and the construction industry.

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Recommendations for specific programs and short-range actions needed to implement the objectives and policies of the COMMUNITY SAFETY PLAN for the general preparedness of the City, especially in the case of a disaster, are outlined in this section. As with other sections of the Plan, the recommended programs will be revised on the basis of comments received during the review process.

Because of their specificity, and the fact that they will have to be up-dated periodically, these programs are proposed for endorsement by the City Planning Commission rather than for formal adoption.

The programs, together with the objectives and policies, provide a basis for evaluating and programming actions on a short- and long-term basis. Such actions include amendments to public codes, procedures to abate hazards from existing structures, scheduling capital improvements for critical community facilities, expansion of emergency operations preparedness, public education regarding hazards and what to do about them, procedures to assure preservation of buildings important to the character of the city, formulating higher standards to reduce risks to the community from certain types of structures, and establishing guidelines and procedures to follow for reconstruction of the City should major destruction occur.

LIFE SAFETY PROGRAMS

As most actions to reduce hazards to life will take place a step at a time and over a long period of time, it is imperative to begin these as soon as possible. Standards appropriate to levels of acceptable risk must be incorporated in programs addressed to reduction of life hazards. Actions to reduce hazards will be

most difficult to effect for existing development due to the numbers of structures affected and associated problems of economics and relocation. Hazard reduction can be most effective in new development, but this will occur only over a long period of time and in relatively small areas of the city.

MINIMUM LEVEL OF ACCEPTABLE RISK

The most effective way to reduce risks will be to incorporate life safety considerations in public codes regulating existing and new development. The minimum levels of acceptable risk should be incorporated in public codes through appropriate specific regulation of uses, and they should be included as a basis for evaluation where agency discretion may apply to a regulation.

Recommendation:

> Develop specific standards and criteria for each level of acceptable risk appropriate to the code into which it will be incorporated. Priority should be given to inclusion of minimum levels of acceptable risk in the Building Code, City Planning Code, and Public Works Code.

HAZARD ABATEMENT

Life safety is most widely threatened by hazards from existing structures. Due to the large number of structures likely to be affected, and the costs and relocation needs involved, a phased program for hazard abatement would not only be the most feasible and acceptable approach but the necessary one. Time is of the essence in the commencement of hazard abatement action. Long-term continuing hazard abatement actions will be needed. In a field of expanding knowledge such as seismic structural design it cannot be assumed that a building designed to present standards of safety will be considered equally safe tomorrow. Modifications to structural design standards will be gradual and incremental. In the process some critical deficiency may be found in some standard previously in effect.

Recommendations:

(1) Establish a comprehensive program for abatement of hazards from existing structures. This program should be jointly developed by the Bureau of Building Inspection and the Department of City Planning.

(2) Identify funding needs and sources for both administration of inspection and enforcement programs, and actual abatement work. Explore possibilities for State and Federal assistance to this program.

(3) Define priorities for inspection and enforcement programs. Highest priority should be given to the residential areas with the highest incidence of pre-Code Type C structures, and those critical community facilities presently in Special Geologic Study Areas.

(4) Undertake the hazard abatement program on a continuing basis. It should include inspection and hazard abatement enforcement actions for more recent structures that might be determined to have structural or safety deficiencies as a result of new design standards and code amendments.

REVIEW OF CODES

Permitted land uses and types of structures and other regulations of the City Planning Code and Building Code have been developed over time and respond to many factors. Geologic factors, however, were considered little, if at all, in these regulations. Consideration of these factors should be included in the appropriate codes.

Recommendation:

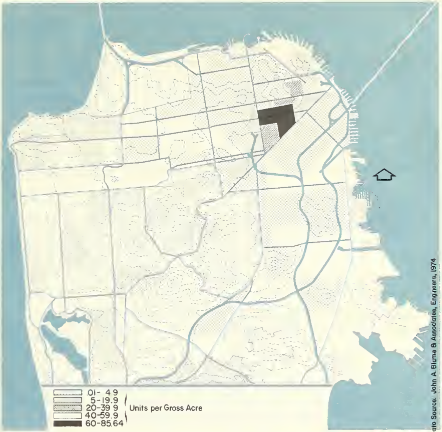
Review the regulations of the City Planning and Building Codes, and other appropriate codes, relative to identified geologic factors and amend the codes as necessary to include full consideration of geologic conditions. The current Residential Zoning Study by the Department of City Planning should include consideration of geologic factors in the determination of land used for residence.

SPECIAL GEOLOGIC STUDY AREAS

The boundaries of the Special Geologic Study Areas policy map represent a conservative estimation of areas subject to seismic hazards. Over time, specific investigations conducted of individual sites will increase the ability to evaluate hazardous conditions, and allow more accurate definition of the Special Study Area boundaries.

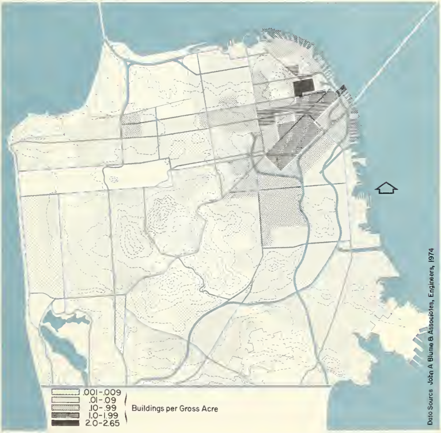
Recommendation:

Establish and maintain a public information data bank containing the results of geologic site investigations undertaken in the Special Geologic Study Areas. At a ten year interval review this data bank and make appropriate modifications to the boundaries of the study areas.



Data Source. John A. Blume & Associates, Engineers, 1974

DENSITY OF PRE-CODE (1948) TYPE C RESIDENTIAL UNITS (by 1970 Census Tracts)



Data Source. John A. Blume & Associates, Engineers, 1974

DENSITY OF PRE-CODE (1948) TYPE C NON-RESIDENTIAL BUILDINGS (by 1970 Census Tracts)

STRONG-MOTION INSTRUMENTATION

Instrumentation of sites in San Francisco to measure the ground motion during large earthquakes is part of a comprehensive seismic research program being conducted by the California Division of Mines and Geology and the United States Geological Survey. For this strong-motion instrumentation program approximately twenty sites have been instrumented and at least ninety more are considered to be necessary to derive adequate ground motion data in San Francisco.

Money to help support this program is partially obtained from a fee equal to .007 percent of the estimated construction costs of projects for which building permit applications are filed in San Francisco. Additionally, the program is assisted by installation of strong motion instruments in public buildings by the City's Department of Public Works through an additional fee of .003 percent of the estimated construction cost on building permit applications.

The City Planning Commission has endorsed this program through Resolution No. 7167 adopted on March 28, 1974 in which it stated "...its intention to consider requiring strong-motion instrumentation in any major building project, or project occupying one or more city blocks, requiring a conditional use approval;" and that "...consideration of such a requirement will be subject to USGS or California Division of Mines and Geology criteria for location and recommendation for instrumentation;..."

Recommendation:

(1) Carry out the intent of City Planning Commission Resolution No.7167 for requiring instrumentation of all large projects requiring a conditional use permit.

(2) Request that the USGS and CDMG pursue preparation and adoption of State legislation which would require provision of space in all new buildings for instrumentation where an advisory board of experts deem instrumentation desirable. Funding for continued maintenance of the additional instruments which would result from this program, and existing local programs, should be made available at the State level

(3) Department of City Planning, Bureau of Building Inspection and other relevant public agencies should consult with USGS and CDMG to assure the completion of the strong-motion instrumentation program in San Francisco.

PRESERVATION PROGRAMS

Elimination of life safety hazards is a primary concern of the objectives and policies of the COMMUNITY SAFETY ELEMENT. However, the unique character and physical appearance of the city is of equal importance to many San Franciscans.

A comprehensive hazard abatement program is needed to assure life safety, and it is inevitable that such a program will affect the appearance of the city. A carefully considered approach is needed to balance the needs for life safety and the importance of preserving the visual character of the city.

PARAPET ORDINANCE AND GENERAL HAZARD ABATEMENT

Structurally unsound parapets and building appendages represent great life hazards from falling, especially during earthquakes. The Building Code was amended in 1969 to require the abatement of hazards from unsafe parapets and building appendages. This will affect primarily older structures and although the inspection and enforcement program of the ordinance has not yet begun, voluntary action to date indicates compliance often results in a severe loss of building character and appearance.

The City Planning Commission, in response to this threat to the character of the city, adopted Resolution No. 7181 on May 16, 1974, stating the Resolution "...its desire to retain, through repair, reinforcement, or replacement, those parapets and building appendages which are of importance to the special character of San Francisco;" and authorized "...the staff of the Department of City Planning to take appropriate actions to encourage preservation of such building elements, especially through cooperative action with the enforcing agency, the Bureau of Building Inspection." Further specific actions should be taken pursuant to this initial step.

Recommendations:

(1) The Bureau of Building Inspection (BBI) should develop the procedures for inspection and enforcement of the parapet ordinance, but in cooperation with the Department of City Planning, should incorporate provisions for preservation where appropriate. They should include:

   a. Department of City Planning review of the structure and hazardous appendages from photographs that would become part of the BBI inspection record; and subsequent department field inspections as needed.

b. Provision for an addendum to be made to the BBI hazard abatement notice. The addendum would be included in any case where preservation or restoration would be desirable. The addendum could state that the building is of importance to the character of the city, and ornamentation ought to be retained or restored.

c. Provision for Department of City Planning review of the proposed alterations, and, if warranted, contact with owner and/or designer to encourage the retention of the building character in the work.

The legal scope of the parapet ordinance would not be altered by recommending conformity to the existing building character, but it would afford the needed opportunity to express the case for restoration, as part of the adminstrative process, in those instances where it was important.

This approach could be a reasonable way to proceed for an interim period of perhaps a year from the beginning of BBI enforcement. After a year the results could be evaluated, with the voluntary approach continued, or more formal City Planning Commission or legislative actions considered that would achieve the retention of building character without delaying the enforcement program.

(2) Prepare a cooperative inspection and enforcement procedure similar to (1) above when a comprehensive hazard abatement program becomes effective to encourage preservation of buildings and structures where appropriate and desired.

INCENTIVES FOR PRESERVATION

Various incentives could be formulated to encourage preservation or restoration of building ornamentation and character. The Board of Supervisors' Finance Committee at one time considered an incentive through tax relief to owners of property who incurred expenses for correction work on dangerous parapets and appendages. This proposal has been tabled indefinitely.

The possibility still exists for legislative action to provide tax relief, perhaps for either the portion of the remedial work that exceeded the cost an owner would have incurred through simple removal of the hazard, or for the total cost of restoration. Another incentive could be a program of low interest loans with extended repayment schedules similar to those now in use for code enforcement areas.

The use of special tax considerations relates to the taxation powers of a municipal government, and special enabling legislation might be required at the State level. Action should be taken to explore, at both the State and local levels, the potential of a tax incentive credit system for structural hazard abatement. Such a system might be used not only in abatement of parapet hazards but also in abatement of hazards present in the basic structure of many buildings. Potentially dangerous structures can easily be identified, but the city presently lacks a viable economic mechanism for encouraging the abatement of any of the hazards. State or Federal programs might also be a source of financial assistance to promote restoration and preservation of buildings.

Officially designated landmarks threatened with demolition by the burden of hazard abatement costs might especially be considered for special funding assistance.

Recommendation:

> Explore possible sources of financial assistance to provide incentives for preservation of buildings and building elements important to the visual appearance of San Francisco. Grants, low-interest loans, and tax incentives especially should be investigated for possible application to preservation uses.

ALTERNATIVE MATERIALS FOR RESTORATION

A major obstacle to efforts to safely restore buildings to their original appearance are the high costs to reproduce ornate decorative building elements that often were originally crafted in stone or terra cotta. The complexities of safe anchorage of these often heavy elements increase costs even more. The development of inexpensive, lightweight materials and simple methods for reproducing decorative elements is necessary to avoid widespread undesirable modifications to existing buildings.

Recommendation:

> Initiate research to develop materials and methods that would be economically viable for architectural and historic preservation application and conform to structure and fire safety standards. This would most appropriately be undertaken by private preservation organizations through special public or private foundation grants.

EMERGENCY OPERATIONS PROGRAMS

In many ways, San Francisco emergency operations preparations are well advanced. The groundwork has been laid for a good emergency planning network and an adequate basic Emergency Operations Plan exists. However, there are limitations, especially in the operational capabilities of the designated emergency procedures. It is important that actions be taken in order to remove as many limitations as possible; the following programs provide a framework within which the objectives and policies of emergency operations may be reached.

SAN FRANCISCO OFFICE OF EMERGENCY SERVICES

The Office of Emergency Services is the agency with the comprehensive responsibility for emergency preparations. Activities range from preparation of operations plans to public education. The effectiveness of the Office and service to the community should be continued and increased in several areas.

Recommendations:

(1) Increase the staff of the San Francisco Office of Emergency Services to specifically include an architect, graphics specialist and planner; these added skills are needed to adequately prepare site designs, support materials and long-range plans.

(2) Prepare and conduct a full range of test exercises. They should include:

   a. An annual scheduled testing of the full Emergency Operations Plan, involving all operating agencies and staff members;

   b. At least one annual unscheduled testing of the entire Emergency Operations Plan;

   c. Specific exercises testing the Contingency and Response Plans, in order to ensure that key staff members will understand the different emergency situations created as a result of different disasters;

d. Quarterly testing of emergency communications equipment, including emergency vans and auxiliary equipment, and emergency communications staff members, in cooperation with the Department of Electricity;

e. Detailed test exercising according to specific functions, e.g., a joint hospitals-ambulance-District Health Centers - private physicians exercise or a joint Department of Public Works-Division of Highways-transit systems agencies emergency access debris clearance exercise.

(3) Assist agencies lacking important Functional Emergency Plans in plan development by a set of guidelines and criteria; a sub-committee of the Emergency Planning Committee would be a proper setting for the development of these criteria.

A program of action should be developed to assist participating departments and agencies in the preparation and updating of these needed plans. Included in this program of action should be regular training sessions to ensure that key staff members understand their emergency operations roles.

(4) It is imperative that the public understand earthquake hazards and, in turn, how to reduce the risk caused by these hazards. A public education program explaining seismicity, emergency operations procedures in San Francisco, and what can be done to the private home in order to make it less vulnerable, could be implemented through courses offered in the public schools and adult education centers, and the placement of the critical information in a widely available, convenient permanent location such as the San Francisco Telephone Directory.

EMERGENCY OPERATIONS FACILITIES

Facilities that are both sufficient to fulfill emergency operations requirements and safe from the damaging effects of a major disaster are essential. Some of San Francisco's emergency operations facilities are inadequate, others should be investigated to verify their serviceability or to formulate programs for amelioration of deficiencies.

Recommendations:

(1) Construct a new San Francisco Emergency Operations Center (EOC). To do this the following actions should be taken:

a. Establish an Ad Hoc EOC Committee by the Board of Supervisors to assist in the creation of a new EOC;

b. Find a site, meeting all Federal requirements, through a survey of sites conducted by the SF/OES and the Ad Hoc Committee;

c. Obtain necessary EOC funding, possibly through a voter referendum; a bond package might be assembled to include the EOC with other public utilities or public administrative buildings.

(2) Initiate detailed site-specific geologic and structural investigations of all key emergency operations facilities in order to determine the probable operational capability of the facilities after a disaster. Facilities should be ranked, and in turn investigated by the Bureau of Building Inspection, according to the importance of their use. Structures presenting a substantial risk should be made safe (i.e., constructed so as to be totally operational immediately after an earthquake) or moved to a safer location.

(3) Provide radio communications equipment for every department and agency with an important emergency operations role. This equipment must be tied together, at least for emergency purposes, at one Emergency Communications Dispatch Center, preferably within the new EOC.

FIRE-FIGHTING CAPABILITY

The ability to effectively combat fires is an essential need in most major disaster situations. To do this the highest standards must be maintained for administration, staffing, equipment and facilities for all fire-fighting services.

Recommendations:

(1) Expand the Auxiliary Water Supply System to create a single-line fire break in the western,southern and eastern portions of the City.

(2) Whenever possible, replace the domestic water supply pipes with newer, more flexible materials and connections. This activity should be carried out in conjunction with, and to the standards of, the Fire Department.

(3) Increase, and make more frequent, inspection of equipment for fire safety and prevention.

EMERGENCY ACCESS ROUTES

Primary transportation routes are needed for the provision of emergency services and evacuation. This must be thoroughly considered prior to the time of actual need in order to avoid areas of likely obstruction and to establish the priorities for rapid clearance of the most vital routes.

Recommendation:

> Designate routes for emergency access and evacuation. The reservoir failure evacuation routes should be developed according to the standards of the CA/OES. The emergency access routes should be developed and designated by the SF/OES according to location of critical facilities and location of projected building damage areas to avoid routes that may be blocked but also provide access to those areas where there may be high numbers of injuries.

POST-DISASTER RECONSTRUCTION PROGRAMS

Although a major earthquake will probably cause widespread damage, an important opportunity presented by earthquake-caused destruction should be taken advantage of to effect programs in concert with established Comprehensive Plan objectives and policies, appropriate City codes and other community concerns and needs. Past experience points to the overwhelming necessity of having established methods prior to the disaster for guiding post-earthquake reconstruction. Such reconstruction preparations have great potential to effect actions and changes not possible prior to severe damage, and insure that past errors are not repeated.

RECONSTRUCTION PLANNING COMMITTEE

A means of insuring the advance development of post-disaster reconstruction policies could be through the creation of a Reconstruction Planning Committee to formulate strategies and make recommendations for actions and general preparation.

Recommendations:

(1) Create a Reconstruction Planning Committee. Appointments to the Committee, by the Mayor and the Board of Supervisors, should include, but not be limited to, the following:

Mayor
Board of Supervisors
Office of Emergency Services
Department of City Planning
Department of Public Works
Federal, State and local governmental and private organizations providing:

1. financial assistance;
2. medical, housing and social services; and
3. transportation and transit services, public utilities, labor, business and finance, and the construction industry.

The work of the Committee should focus on these potential needs that are central to the reconstruction effort:

a. Strategies to insure that established community development objectives and procedures are not abandoned or circumvented due to pressures for rapid reconstruction; for example, post-earthquake design standards should be as advanced as possible, regardless of whether such construction takes longer to complete or is more costly.

b. Opportunities to further implement the objectives, policies and criteria of the Comprehensive Plan for San Francisco.

c. Recommendations for contingency legislation critical to proper reconstruction that should be passed before a major earthquake, but would take effect only in the event of an earthquake; for example, special contingency provisions for temporary housing, now prohibited in the City, would be necessary to relieve rapid residential reconstruction pressures.

d. Determination of priorities for allocation of scarce resources; the principal example of this will be building materials and the priorities established regarding the importance of construction projects.

e. Insuring that construction financing programs do not encourage improper reconstruction or reconstruction on unsafe sites; this will best be accomplished through joint agreements between lending institutions, insurance companies, Federal disaster assistance agencies and the Central Permit Bureau of the Department of Public Works whereby money for new construction is not given until a valid building permit is procured.

f. Ways to most effectively communicate with the community regarding availability of disaster assistance and the requirements of reconstruction procedures; one prime way of accomplishing this will be the development of an informational booklet or brochure outlining Building Code requirements, land-use regulations, development objectives, building permit requirements and procedures, the availability of financial aid, and the necessary application procedures. Such information should be made available at one-stop assistance centers, at which the review of permit applications could also occur.

The Committee should be ongoing; once the initial work program is completed it should be reviewed at regular intervals, at least every two years, to assure preparations continue to be adequate and current.

GLOSSARY

ARCHITECTURAL ELEMENTS: Generally, decorative, non-structural elements, such as: cornices, windows, curtain walls, decorative plaster, metal, tile and masonry veneer, and suspended ceilings.

BEARING WALLS: Interior and exterior walls which support the floors and roof of a building.

BUILDING RESISTANCE: Ability of a building to resist horizontal and vertical forces.

EARTHQUAKE ENGINEERING: The engineering design of buildings and structures to resist the destructive effects of earthquakes.

FAULT: A fracture in the earth along which one side has been displaced in relation to the other. An active fault is one in which movement has occurred within the past 10,000 years.

FAULT CREEP: Very slow, periodic movement along a fault, unaccompanied by an earthquake.

FIELD ACT: California State Law enacted following the 1933 Long Beach earthquake requiring lateral force resistance for earthquakes in school buildings. Among many other things, this Act requires the State Office of Architecture and Construction to set up rules and regulations concerning earthquake safety in the design and construction of school buildings. These regulations are now included in Title 21 and Title 24 of the California Administrative Code.

GROUND ACCELERATION: The rate of change in the velocity of a seismic wave passing through the earth.

GROUND FAILURE: A situation in which the ground does not hold together, which includes landslides, liquefaction and subsidence.

GROUND RESPONSE: The reaction of the ground to earthquake shaking.

GROUND SHAKING: Movement of the earth's surface due to the shock waves created by an earthquake. The intensity of ground shaking is affected by the geology of the site, nearness to the fault and the duration of the shaking.

HAZARD: A source of danger. A geologic hazard would be an active landslide. A structural hazard would be a building which may collapse, especially during an earthquake.

INTENSITY: A subjective measure of the force of an earthquake at a particular place as determined by its effects on persons, structures and earth materials. A commonly used measure is the Modified-Mercalli Intensity Scale of 1931.

LAND-USE PLANNING: The process of designating land for various uses and activities, such as, residence, commerce, industry, open space, and community facilities.

LATERAL FORCE DESIGN: Design or engineering of a building to resist the horizontal forces of earthquakes or wind.

LIFELINES: The major utility and transportation systems vital to the functioning of a city, such as, gas, electricity, water, sewage, transportation, and telephone.

LIQUEFACTION: A process by which loosely consolidated soil loses its cohesiveness when shaken, leading to a quicksand condition. This condition lasts only for the duration of shaking, then the soil will return to its prior state.

MAGNITUDE: A measure of the strength of an earthquake, or of the strain energy released by it, as determined by seismographic observations. It is based on a logarithmic scale, each upward step of one magnitude unit is equivalent to a 32 fold increase in energy release. Magnitude, different from intensity, is measured on the Richter Scale.

MODIFIED MERCALLI SCALE: A scale developed by Guiseppe Mercalli to measure the intensity of an earthquake, as opposed to the magnitude, of an earthquake. It was modified by Charles F. Richter in 1956. The scale ranges from I to XII.

NON-STRUCTURAL ELEMENTS: Those architectural or mechanical parts of a building that are not calculated in the design of the supporting structure.

PARAPETS/CORNICES: A parapet is a vertical extension of the exterior wall of a building above the roof line. A cornice, on the other hand, is the horizontal molding projecting from the wall of a building, usually near or at the top of the wall.

PERIOD: The interval of time necessary for a regularly recurring motion, as in a building or the ground, to make a complete cycle.

PLUMB: Straight up and down, vertical. A structure out of plumb will not be vertical to the ground.

PRE-CODE TYPE C BUILDINGS: Those buildings constructed before 1948 that have masonry or concrete exterior bearing walls with wood floor and wood roof construction. This type of construction should not be equated to contemporary Type 3 buildings designed and constructed under modern seismic code provisions.

RICHTER SCALE: A logarithmic scale developed by Charles Richter to measure the magnitude, as opposed to the intensity, of an earthquake.

RISK: The possibility of loss or injury. An acceptable level would be the degree of risk that would be tolerated in a given situation, beyond which it would be considered unnecessary or undesirable to further reduce risk.

SEICHE: A back and forth movement of water caused by seismic activity in a lake or other contained landlocked body of water. As with a tsunami, it will vary in duration and result in fluctuation of the water level.

SEISMIC: Pertaining to an earthquake or earth vibrations.

SEISMOGRAPH: An instrument that makes a permanent continuous record of earth vibrations.

SILT: Any earthy material composed of fine particles, as soil or sand, suspended in or deposited by water.

SITE - SPECIFIC GEOLOGIC/SOILS ANALYSIS: An investigation of the geology, soil, and rock conditions of an individual site to determine the soil characteristics and soil bearing capacity of the site.

STATIC CONDITIONS: Acting through weight or gravity only; refers to the pressure exerted by a motionless body or mass.

STRONG-MOTION INSTRUMENTS (ACCELEROGRAPHS): A type of seismograph, modified to measure only the stronger vibrations generated by local earthquakes.

SUBSIDENCE: The sinking of land areas. Generally long-term in nature, rapid and uneven settlement may be caused by a major earthquake.

TSUNAMI: A sea wave produced by large areal displacement of the ocean bottom, usually the result of earthquakes or volcanic activity.

WATER TABLE: The upper limit of the portion of the ground wholly saturated with water. This may be very near the surface or many feet below it.

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